FISHERY CONTRIBUTIONS, ESCAPEMENTS, HARVEST RATES, MIGRATORY PATTERNS AND SURVIVAL RATES OF WILD COHO SALMON (*Oncorhynchus kisutch*) STOCKS IN SOUTHEAST ALASKA BASED ON CODED-WIRE TAGGING STUDIES, 1986-1991

By

Leon D. Shaul

Regional Information Report[1] No. 1J91-21

Alaska Department of Fish and Game
Division of Commercial Fisheries
Juneau, Alaska

December 1991

[1] The Regional Information Report Series was established in 1987 to provide an information access system for all unpublished divisional reports. These reports frequently serve diverse ad hoc informational purposes or archive basic uninterpreted data. To accommodate timely reporting of recently collected information, reports in this series undergo only limited internal review and may contain preliminary data; this information may be subsequently finalized and published in the formal literature. Consequently, these reports should not be cited without prior approval of the author or the Division of Commercial Fisheries.

AUTHOR

Leon D. Shaul is the Southeast Alaska Coho Research Project Leader for the Alaska Department of Fish and Game, Division of Commercial Fisheries, P.O. 20, Douglas, AK 99824.

ACKNOWLEDGMENTS

Kent Crabtree did much of the material preparation, field supervision, scale reading and data entry for the projects reported in this manuscript. The author also appreciates the efforts of the many field employees who collected the basic data essential to the development of this report including: Larry Derby, Rebecca Wilson, Susan Jordan, Elizabeth Wilson, Wayne Lonn, Molly Kemp, Nick Olmsted, Ken Koolmo, Karen Koolmo, Kent Taylor and John Preus. Jerry Koerner assisted in supervision of the smolt tagging and adult weir operations at Hugh Smith Lake. Thanks also to Gary Gunstrom for his editorial review and to Julie Kallem for final preparation of the manuscript.

PROJECT SPONSORSHIP

This investigation was partially financed by the Anadromous Fish Conservation Act (P.L. 89-304 as amended) under Federal Aid Grant Award No.s NA86-ABD-00301, NA87-ABD-00301, NA88-ABD-00304, NA89AA-D-FM110 and NA90AA-D-AN246.

TABLE OF CONTENTS

TABLE OF CONTENTS (Continued)

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

ABSTRACT

Wild juvenile coho salmon were coded-wire tagged and returning adults were enumerated and sampled in three stream systems in Southeast Alaska in order to estimate total escapement, fishery contribution, removal rates, migratory patterns, age structure and survival rates. The systems included the Berners River located along Lynn Canal north of Juneau, Ford Arm Lake on the outer coast of Chichagof Island north of Sitka, and Hugh Smith Lake on the mainland southeast of Ketchikan. Total smolt migrations were estimated at Hugh Smith Lake (1983-90) and the Berners River (1989-90). Returning adults to all three systems were sampled in the fisheries and escapements for coded-wire tags. The escapements, fishery contributions, harvest rates, removal rates by fishery, survival rates and the spatial and temporal distributions of the harvest were estimated for the three stocks. The primary purpose of the program was to index fishery harvest rates and patterns and, over the longer term, to determine the effect of escapement and other factors on adult production. Estimated average harvest rates for the three indicator stocks by the Alaska troll fishery during the period 1982-90 showed a stable trend, with a low of 38.1% in 1988, and a peak of 55.0% in 1989. The average harvest rate estimate for the Alaska troll fishery by stock was 47.5% for the Berners River, 52.3% for Ford Arm Lake and 36.4% for Hugh Smith Lake. The average for all stocks and all years was 44.9%. Total harvest rates by all gear types varied substantially among the stocks. The Berners River stock, which is exposed to the Lynn Canal drift gill net fishery, was harvested at an estimated average rate of 75.3% (range 61.9-92.9%). The troll and drift gill net fisheries had approximately the same impact on that stock with average removal rates of 0.480 and 0.513, respectively. The Ford Arm Lake stock which is harvested primarily by the troll fishery, was harvested at an estimated average rate of 55.8% (range 43.6-69.1%). The Hugh Smith Lake stock was harvested by several fisheries at an estimated average total harvest rate of 66.2%. The estimated harvest rate for the Hugh Smith Lake stock increased from an average rate of 61.8% (range 52.3-66.5%) during 1982-1988 to 82.1% in 1989 and 81.1% in 1990. During 1980-89, juvenile coho salmon tagged in the Berners River in late June returned to the fisheries and escapement at an estimated average rate of 5.3% (range 2.9-8.8%). Ford Arm Lake juveniles tagged in July and August survived at an estimated average rate of 9.5% (range 6.0-14.4%). Smolts that migrated from Hugh Smith Lake survived at an estimated average rate of 10.7% (range 4.2-19.1%). Smolts that migrated from the Berners River in 1989 survived at an estimated rate of 19.8%. At Hugh Smith Lake, five years of age .1 coho salmon escapements ranging from 903 to 2,144 produced a narrow range of estimated smolt migrations (23,480-29,548). No relationship between escapement and smolt production was evident from this limited data. Recent results continue to support earlier conclusions about the relative stability of coho production from some lake systems and the important effect of marine survival rates on adult production. Determination of spawner-recruit relationships for the Hugh Smith Lake stock and the other indicator stocks will require several more years of production estimates from a broader range of escapements.

KEY WORDS: Coho salmon, coded-wire tag, indicator stock, migration patterns, migratory timing, harvest rate, Southeast Alaska.

INTRODUCTION

The coho salmon (*Oncorhynchus kisutch*) is an important species to commercial, sport and subsistence fisheries in Southeast Alaska. During 1981-1990, the annual commercial catch averaged 2,100,000 fish and ranged from 1,100,000-3,300,000 fish. Commercial fisheries have accounted for the vast majority of the total harvest, while sport and subsistence fisheries have taken only about 3%.

The majority of the coho salmon harvested in Southeast Alaska are produced in over 2,000 local streams. Important contributions are also made by the Canadian portions of three major transboundary rivers (Stikine, Taku and Alsek) and by streams along the British Columbia coast. Management of fisheries for coho salmon in Southeast Alaska is complicated by the scattered distribution of the resource and highly mixed-stock nature of most of the fisheries. Effective management requires an understanding of the migratory characteristics, status, productivity, harvest rates and contribution to the fisheries of stocks or groups of stocks.

In order to better understand the migratory nature of wild coho salmon stocks and the effects of the fisheries, a juvenile and smolt marking program was initiated in 1972. In the early studies, fish were marked with fluorescent pigment (Gray et al. 1978), while coded-wire tagging equipment was employed in more recent studies beginning in 1976. To date, wild coho salmon have been marked in 24 systems throughout the main part of Southeast Alaska and five systems near Yakutat. Earlier studies focused on characterizing the rates and time-area distributions of the harvest of stocks from different areas of the region (Shaul et al. *In Press*). As more of this type of information has become available, program emphasis has shifted to long-term research on selected "indicator stocks". In addition to providing additional information on harvest rates and patterns, these ongoing studies are directed at providing data on population dynamics that are expected to be useful in establishing objective escapement goals and developing models to predict abundance. Established wild stock indicator systems since 1982 include the Berners River and Auke Creek north of Juneau, Ford Arm Lake on the outer coast, and Hugh Smith Lake south of Ketchikan (Figure 1).

This report includes a summary and analysis of tag release and recovery data for three primary wild Southeast Alaska coho salmon stocks under study by the ADF&G, Commercial Fisheries Division, during the period from 1 July 1986 - 30 June 1991. These include the Berners River, Ford Arm Lake and Hugh Smith Lake. For comparison, data from prior years is included for those systems for which it is available. Studies at Auke Creek were funded jointly by the ADF&G, Division of Sport Fish, and the National Marine Fisheries Service. Reports for the Auke Creek project are published in the ADF&G, Division of Sport Fish's Fishery Data Series.

SMOLT AND PRESMOLT TAGGING

Migrating coho salmon smolts were tagged annually at Hugh Smith Lake during 1982-91 and at the Berners River during 1989-91. Presmolt coho salmon were also

tagged at the Berners River sporadically from 1972-77, during 1980-81 and during 1983-1988. Presmolts were tagged at Ford Arm Lake in 1980-81 and 1983-90. The majority of surviving fish that were tagged as age-1 rearing juveniles were expected to return as adults two years later, while those tagged as outmigrating smolts were expected to return to the fisheries and spawning grounds after only one year at sea.

Methods and Procedures

Migrating smolts were captured for tagging at Hugh Smith Lake and the Berners River. A smolt weir was installed at the outlet of Hugh Smith Lake, while smolts in the Berners River were captured at beaver dams using trough traps of the design described by Elliott and Kuntz (1988). Wire-mesh minnow traps baited with salmon roe were used to capture age-1+ and older juveniles at Ford Arm Lake and the Berners River. Fifty traps were set and checked four times daily at two-hour intervals under normal water conditions. Up to 100 traps were set and checked twice daily under cold water conditions (less than 11° C) when fish were less active. Traps were moved frequently to maintain the highest possible catch rates. Juveniles were held in pens before tagging until a total of 1,000 to 4,000 was captured, but not for a period longer than three days. Gray and Marriott (1986) describe the minnow trapping method in detail. Outmigrating smolts were tagged and released daily. A description of the coded-wire tagging technique under field conditions is found in Koerner (1977).

At the Hugh Smith Lake and the Berners River, a target of 600 and 850 samples, respectively, was taken for age and length. Ten percent of the daily catch was sampled up to a daily maximum of 50 fish. Five to ten scales were taken from the left side of the fish approximately two rows above the lateral line along a diagonal downward from the posterior insertion of the dorsal fin to the anterior insertion of the anal fin (INPFC 1963). The scales were removed with a surgical scalpel and distributed separately across one of four quadrants on a glass microscope slide. Samples from four fish were placed on each slide which was labeled with numbers and corresponding lengths on the frosted end. When a slide was full, another slide was fastened over it with clear tape to protect the scales. All smolts that were sampled for scales were measured from snout to fork to the nearest millimeter.

During May-June 1989-1991, minnow traps were used to capture a mixture of smolts and rearing juveniles at the Berners River. In 1989 and 1991, an effort was made to segregate fish into these classifications based on the presence of smolt characteristics (silvery appearance and darkened fins). Fish that had definite smolt characteristics were tagged with a separate code than fish that had features typical of rearing fish or were impossible to classify objectively. There was a great deal of uncertainty in classifying many of these fish.

Results

Tag releases at the three sites are listed by year, tag code and classification (smolt, presmolt or mixed) in Tables 1-3.

Berners River Smolts and Presmolts

During 1972-1988, presmolt coho salmon in the lower Berners River were captured for tagging during 11 years (Table 1). The total number tagged ranged from 7,826 in 1981 to 15,326 in 1984 and averaged 10,372. These fish were captured in late June and were expected to remain in freshwater for an additional 11 months before migrating to sea. Two trough traps employed on a beaver pond in May through early June 1989 were used to catch 6,438 smolts for tagging. Two trough traps were installed on a second pond during the following season, resulting in a total trough trap catch of 23,598 smolts in 1990 and 21,456 smolts in 1991. Minnow traps were used in addition to trough traps to capture a mixture of smolts and rearing juveniles including 5,660 in 1989, 2,781 in 1990 and 3,669 in 1991. A total of 1,021 fish in 1989 and 1,414 fish in 1991 that were captured in minnow traps were identified as smolts based on coloration, and they were tagged with a separate code.

Ford Arm Lake Presmolts

The number of presmolts tagged at Ford Arm Lake in July and August ranged from 3,882 (1983) to 12,567 (1988) with an average of 8,828 (Table 2). Numbers tagged generally increased in later years with a range of 9,506-12,567 (average 10,774) during 1986-1991. The length of tagging trips remained steady at 12 days. The increase in the number tagged probably reflects increased experience, ability and effort of the tagging crew. Fish were captured from three primary locations including: (1) shoreline and shallow offshore areas of the lake, (2) the outlet stream, and (3) a small pond near the north end of the lake.

Hugh Smith Lake Smolts

Minnow trapping efforts in 1980 and 1981 resulted in tagging of 5,345 presmolts and 3,737 presmolts, respectively. During 1981-1991, a smolt weir at the outlet of Hugh Smith Lake was operated from mid-April through late May or early June. The number of smolts marked varied substantially from 2,777 in 1981 to 16,747 in 1984 (Table 3). The numbers captured for tagging appeared to be related in part to how well the weir was sealed along the stream bottom. Substantial efforts by scuba divers at removing logs and other debris from the bottom appear to have been responsible for capture efficiencies of over 50% in 1983 and 1984. However, divers were unavailable for such work in later years and the efficiency of the weir declined to only 14% in 1987 before increasing again to 27% in 1989 and 34% in 1990. The increase after 1987 has likely resulted from installation of a new, better-fitting weir, increased efforts to seal the weir, and measures to discourage use of the weir site by river otters. The fact that a seemingly well-sealed weir appears to be so ineffective at capturing smolts also raises the possibility of a separate migration of fry or smolts from the system during some time period between early June and mid-April when the weir is not in operation.

ADULT TAG RETURNS

Methods and Procedures

Tag Recovery from Fisheries

Marine fisheries in Southeast Alaska and northern British Columbia were sampled for coded-wire tags. Commercial catch sampling for coded-wire tagged coho salmon in Southeast Alaska was conducted by ADF&G sampling personnel stationed at fish processors and buying stations located throughout the region. The samplers watched for adipose clipped coho salmon during off-loading and sorting operations. Skippers of fishing vessels and tenders were interviewed to determine fishing districts (Appendix B.1). The heads of all adipose fin-clipped fish were sent to the ADF&G Coded-wire Tag Lab in Juneau for removal and decoding of tags. Areas used in expanding random recoveries from the troll fishery were four quadrants (Appendix B.2), while recoveries from net and trap fisheries were expanded by district. Time strata used for expanding net and trap recoveries were statistical weeks (Appendix B.3), while troll fishery samples were expanded over the total catch for open periods (between closures). Exceptions were that troll recoveries were expanded by statistical week-quadrant for analysis of migratory timing and period-PMFC area for analysis of harvest distribution. Randomly recovered tags were expanded by the inverse of the proportion of the catch that was sampled within area, gear type and weekly or period strata, while adjustments were made to account for lost samples (Clark and Bernard 1987). An adjustment for lost samples was made by multiplying expansions by the inverse of the proportion of heads and tags lost.

The ADF&G Sport Fish Division conducted a creel census and survey of the Juneau and Ketchikan marine recreational fisheries (Suchanek and Bingham 1991). Tags recovered from random samples were expanded over biweekly strata that contained additional stratifications including weekdays, mornings vs. afternoons, and low use vs. heavy use docks.

Sampling of British Columbia coastal fisheries and reporting of coded-wire tag recoveries was conducted by the Canada Department of Fisheries and Oceans (DFO).

Escapement Enumeration and Sampling

Coho salmon escapements were enumerated or estimated at Ford Arm Lake, Hugh Smith Lake and the Berners River. As many fish as possible were examined for adipose clips at weir sites and during sampling operations on the spawning grounds.

Age-length-sex samples were taken from a target sample of 500 adult fish captured from the Berners River using a beach seine, and from 600 fish each from the migrations at the Ford Arm and Hugh Smith weirs. Each fish that was sampled for age-length-sex was placed in a padded measuring trough and measured to the nearest millimeter (mideye-fork length). Fish sampled at the weirs were anesthetized in a solution of MS-222, while fish sampled at the Berners River were not. The length and sex were recorded. Four scales were taken from the left side of the fish approximately two rows above the lateral line along a

diagonal downward from the posterior insertion of the dorsal fin to the anterior insertion of the anal fin (INPFC 1963). Scales were mounted on gum cards and impressions later made in cellulose acetate (Clutter and Whitesel 1956).

Daily weir counts and age-sex-length data are reported by Wood (*In press*).

Berners River Surveys. The upper Berners River was surveyed annually by foot and helicopter during a 10-day trip in late October. Access was by helicopter to a campsite located just downstream from the major spawning area. A thorough escapement survey of the upper river and tributaries was conducted by foot immediately after arrival. An additional survey was conducted later in the trip if there was evidence that more fish had moved into the upper river. The survey area was covered on two sequential days, from camp to the headwaters on the first day, and downstream on the second day. All side tributaries throughout the survey area were examined for fish. When the helicopter returned to remove the camp, the observer surveyed the lower river from the mouth upstream to the downstream end of the foot survey area. Typically, few fish (less than 10% of the total count) were seen in this area. The total survey count was the sum of all fish seen in the system. Care was taken to schedule surveys to minimize the chance of double counting the same fish or missing fish as they moved between survey sections in the interval between surveys.

The same observer conducted the Berners River surveys during 1982-1990. The observer wore polarized sunglasses. In headwaters sections and tributaries, the observer walked upstream along the bank or in the stream channel, if necessary, to avoid dense vegetation. The observer looked ahead and counted fish individually as they darted downstream past the observer or under banks or logs. Rocks were thrown into suspected hiding areas to drive fish out to be counted. In some small tributaries with overhanging root systems, the observer probed under banks to drive hiding fish out to be counted. Pools with larger schools of over 100 fish were counted repeatedly from different angles and directions until the observer was satisfied with the count, which was typically the average of several counts. The observer moved quietly and slowly along the bank above the fish and attempted to count without disturbing them. Counting larger schools was often done by tens, or alternately by tens and hundreds for the largest observed aggregations of 1,500-2,000.

Coho salmon carcasses were extremely rare; however, any dead fish or fresh parts (jaws or pyloric caeca) that could be identified as individual fish were included in the count. Species identification was not a problem as coho was the only salmon species present in the area during late October, although schools of Dolly Varden were present in some areas.

Helicopter surveys of the lower river were conducted from an altitude of 30-50 m with the sun at the observer's back. The helicopter was first held stationary, off to the side of the pool, so that prop wash on the water did not obscure visibility and so that the fish remained somewhat stationary and did not stir up bottom sediment. The helicopter sometimes moved past the fish or in a circle around them if the observer needed to see their movement to confirm that he had observed them all.

The trip was timed so that little if any spawning had occurred before the survey count, while the vast majority of the run had entered the system from saltwater. Fish were just beginning to enter headwaters spawning areas and small tributaries, while most were holding in clear pools. The 10-day trip was long enough to allow for periods of unfavorable survey conditions due to high water.

Fish were captured with a 13 m beach seine for sampling for coded-wire tags and age-length-sex data. The coded-wire tag sampling objective was at least 1,500 fish or 25% of the total survey count. The beach seine was deployed in holding pools by a three person crew. Fish that were captured in the beach seine were marked with a partial dorsal clip using wire cutters and examined for a missing adipose fin. If the fish was unmarked, it was released. In earlier years, when an adipose clip was found, the fish was sacrificed and the head was sent to the ADF&G tag lab for tag removal and decoding. However, a greatly increased tagging rate beginning in 1989 led to a need to sample marked fish without killing them. In 1990, adipose clipped fish were examined with a magnetic field detector to determine the presence of a tag. If the fish registered a positive signal when it's head was moved quickly both ways through the detector, it was released and recorded as having a tag. If a coded-wire tag was not detected, it was sacrificed and the head was marked with a jaw tag and sent to the tag lab for further verification.

Ford Arm Lake Weir. A wooden tripod and metal picket weir, approximately 43 m long, was operated at the outlet of Ford Arm Lake from approximately August 15 through at least October 24 during 1981-1982 and 1985-1990. The weir was kept in place until mid-November in 1982 and 1983, but the season was shortened in 1985 when it became obvious that few or no new fish entered the system after late October. Spawning usually began to occur downstream from the weir in mid to late October. Thorough downstream surveys were conducted from October 7 until the weir was removed, whenever conditions were favorable. Subsequent cumulative weir counts were subtracted from each survey count and the greatest difference between these numbers was recorded as the number of fish remaining downstream when the weir was removed.

In 1982 and 1983, the weir became ineffective for periods due to water flowing over the top and mark-recapture estimates were made in those years (Shaul et al 1985 and 1986). This problem was largely solved by installing a railing with a hardware cloth extension along the top of the weir to maintain a complete barrier in flood conditions. However, minor problems with the integrity of the weir have occurred in some recent years when bears have opened holes in the wire mesh during critical high water periods. This has necessitated tagging and recovery to estimate the escapement. Years when the mark-recapture technique was used to estimate the escapement were 1982, 1983, 1988, 1989 and 1990.

All healthy coho salmon that passed through the weir were captured in a trap, sampled for coded-wire tags and marked with a partial dorsal clip. The posterior three rays of the dorsal fin were sheared with wire cutters approximately one cm above the fish's back. In 1982 and 1983, fish were tagged with numbered Floy anchor tags (Shaul et al. 1985 and 1986). However, data from those years indicated virtually complete intermixing of marked fish between tagging and recovery and, therefore, that a single stratum estimate (Chapman 1951) should be unbiased. In 1982, elapsed time between tagging at the weir and live recovery

in the inlet streams ranged from 1-78 days (Shaul et al. 1985). Therefore, application of numbered tags was discontinued because of the expense and high tag loss rates. The dorsal clip was been employed as the primary mark in more recent years because it was easier and less expensive to apply. It also appeared to have virtually no loss rate on live samples which accounted for nearly all recovery samples at Ford Arm Lake.

When necessary, recovery sampling was initiated in mid-October. All fish that passed the weir after recovery sampling began were marked with a left opercular punch rather than a dorsal clip so that they could be distinguished if recaptured, and they were excluded from the mark-recapture estimate. Recovery sampling was conducted primarily with sport spinning gear and, in some cases, beach seines and dip nets. Two rods were fished at locations around the lake. Fish that were captured were marked with a right opercular punch and sampling was conducted without replacement until 50 fish were captured. If more than one fish without a dorsal clip or left opercular punch was captured in this sample, sampling effort was continued until the weir was removed in late October.

If no fish were found to have passed the weir uncounted, the gross adult (age .1) escapement estimate included the sum of the following: (1) total weir count including all weir mortalities and fish that were sacrificed for samples; (2) the greatest difference between a downstream survey count and the weir count after the survey was made; and (3) the sum of pre-spawning mortalities observed in downstream surveys. If fish were found to have passed the weir uncounted, the gross estimate included the sum of the following: (1) Chapman estimate of the population above the weir when recovery sampling was initiated; (2) fish counted upstream past the weir and marked with a left opercular punch after recovery sampling was initiated; (3) upstream migrant mortalities that occurred at the weir including fish that died in the trap or were killed by bears and fish that were sacrificed as samples; (4) unspawned wash-ups on the weir (assumed to be handling mortalities and not included in the Chapman estimate); (5) the greatest difference between a downstream survey count and the weir count after the survey was made; and (3) the sum of pre-spawning mortalities observed in downstream surveys. Estimates of gross escapement were used in calculating total return, harvest rates and juvenile-adult survival rates. Net escapement is the gross escapement estimate minus pre-spawning mortalities that are human-inflicted (trap mortalities, bear kills at the weir, coded-wire tag samples, and unspawned wash-ups). Net escapement is used to estimate brood year escapement for spawner-recruit analysis.

The coho salmon escapement at Ford Arm Lake was sampled for coded-wire tags. All fish that were counted past the weir were captured in the trap and examined for the presence of an adipose fin. In 1982 and 1983, a sample of 20 adipose clipped adults was sacrificed and examined for tags at the tag lab. If any were found to have lost tags, additional samples were taken from up to 50 fish. In more recent years, fish that had clipped adipose fins were examined with a magnetic field detector to determine whether or not a tag was present. Marked fish that did not register a positive signal, passing both directions through the detector, were sacrificed and the heads are sent to the ADF&G coded-wire tag lab in Juneau for further verification. An individual record was made of each fish that passed the weir including whether: it was an adult (age .1) or jack (age .0); whether or not it had an adipose clip; and if clipped, whether or not it registered a positive signal on the detector. Age-length-sex samples were recorded on the

same form. Each adipose clipped fish that did not register a signal on the magnetic field detector was sacrificed, a numbered cinch strap was attached to the head and the number was recorded on the form.

At Ford Arm Lake, males under 460 mm mid-eye fork length were classified as jacks (age .0), while other fish were classified as adults (age .1). There was a chance of misclassifying a very small number fish because of a small overlap between size distributions of the two ocean age classes. Not all jacks were enumerated as some were small enough to pass between the pickets.

Hugh Smith Lake Weir. During 1982-1990, the Hugh Smith Lake Weir was operated for sockeye salmon beginning in early June and continued through late October. The weir was kept in operation through late November in 1982-1984, but a lack of new migrants after late October indicated that the season could be shortened without undercounting the escapement.

Fish remaining downstream of the weir were carefully counted before the weir was removed and were added to the weir count to obtain a total escapement count.

Extreme flow rates threatened to destroy the weir structure in some years (1982, 1983, 1986 and 1987) and pickets were pulled for a period or hours or days to relieve pressure. This permited fish to escape upstream uncounted and unsampled and necessitated tagging and recovery to estimate the escapement. The older wooden tripod weir was replaced in 1989 with a much stronger aluminum bipod structure which performed without problems in flood conditions during 1989 and 1990.

All healthy adult coho salmon that passed through the weir were captured in a trap, sampled for coded-wire tags and marked with a partial dorsal clip. In 1982 and 1983, fish were tagged with numbered Floy anchor tags (Shaul et al. 1985 and 1986). A stratified estimate was made using the technique developed by Schaefer (1951). Tagged fish were recovered on the spawning grounds from mid-November until early February. The data indicated that there was nearly complete intermixing of fish between marking and recovery, while a single stratum estimate (Chapman 1951) resulted in relatively low bias compared with the stratified estimate (6.9% bias in 1982 and 2.2% in 1983). Therefore, the dorsal clip has been employed in more recent years because it is easier and less expensive to apply.

Recovery sampling was initiated in mid-November and continued through late January if there was any indication that fish may have escaped past the weir uncounted. Two or three-day recovery trips to Hugh Smith Lake were made by float plane, if possible, or by helicopter if the lake surface was frozen. The inlet streams, Buschman and Cobb Creeks, were surveyed on foot and fish were captured for sampling using dipnets and a beach seine. Additional fish were captured off the mouths of the inlet streams using sport gear. All fish that were sampled were marked with a single left opercular punch and released. All marks (ad clip, dorsal clip, opercular punch) on recovery samples were recorded and the fish were classified as adults (age .1) or jacks (age .0).

The coho salmon escapement at Hugh Smith Lake was classified by ocean age and sampled for coded-wire tags using the same techniques employed at Ford Arm Lake.

Most fish that were counted past the weir were captured in a trap and examined for the presence of an adipose fin. At Hugh Smith Lake, males under 450 mm were classified as jacks, while other fish were classified as adults.

Analysis of Tag Recovery Data

The proportion of fish in the escapement that were tagged (Θ_t) was estimated as follows:

$$\Theta_t = \left(\frac{m_1}{s}\right)\left(\frac{t}{m_2}\right)$$

where S = number of fish in the escapement sampled for adipose clips

m_1 = number of fish in sample (S) that had adipose clips

m_2 = number of adipose clips in the escapement sampled for tags

t = number of adipose clipped fish in the escapement that were sampled for tags and were found to have tags.

The total number of tagged fish in the escapement (E) was estimated by multiplying the total estimated escapement (N) by the proportion tagged (Θ_t).

$$E = N\,\theta_t$$

Four harvest related parameters are defined below.

1. Stock distribution is the distribution of the catch and escapement of a stock expressed as a proportion of the total return (catch and escapement).

2. Harvest rate is the total harvest of a stock by one or more fisheries divided by the total return (catch and escapement).

3. Removal rate is the total harvest within a defined fishery divided by the total number of fish available within that fishery.

4. Harvest distribution is the distribution of the catch of a stock among the fisheries by area and/or gear type expressed as a proportion of the total catch of that stock.

Harvest by Gear Type and Escapement. The estimated harvest by gear type and escapement were computed for coho salmon returns to the three systems (Tables 4-6). Alaska troll fishery tag recoveries were expanded to total catch by quadrant (Appendix A.2) and fishing period (time between fishery openings and closures). Recoveries from net fisheries were expanded by District and statistical week

(Appendix A.3). Fishery contribution estimates for tagged fish were divided by the proportion tagged in escapement samples (Θ_t) to estimate total stock contributions C_i.

$$C_i = \frac{F_i}{\theta_t}$$

where F_i = estimated number of tagged fish harvested (expanded sum of random fishery recoveries) in fishery i

The total run size (X) was estimated by adding the sum of the estimated catch of the stock in all fisheries and escapement.

$$\textit{Total run size } (X) = \sum C_i + N$$

Harvest Rates. The harvest rate (H) for a stock in fishery i was estimated as follows:

$$\textit{Harvest Rate } (H_i) = \frac{F_i}{\sum F_i + E}$$

The total harvest rate by all fisheries was estimated as follows:

$$\textit{Total Harvest Rate } (\sum H_i) = \frac{\sum F_i}{\sum F_i + E}$$

Harvest rate estimates were summarized for the Alaska troll fishery and all fisheries combined (Table 7; Figure 3).

Removal Rates. In sequential "gauntlet" type fisheries such as occur for coho salmon in Southeast Alaska, removal rate estimates for distinct fisheries provide a clearer understanding of management options for achieving desired escapement than do stock distribution or harvest rate estimates. Removal rates are independent of harvest by previous fisheries and, therefore, provide a measure of the effect of a particular fishery on a migrating population of fish.

Therefore, removal rate estimates are an important component of postseason management assessment and are useful for developing future management strategies.

For this analysis, the number of fish available to a fishery is considered to be the total number of fish that migrate through the area where the fishery occurs. The number of fish that pass through a fishing area is the estimated total return (catch and escapement) minus fish harvested in preceding fisheries. Therefore, it is necessary to assume a direction of migration. In this analysis, it was assumed that returning coho salmon migrated by the most direct route(s) from the open ocean toward their systems of origin and that they could not pass around the fisheries. Suppose that T_2 is the number of tagged fish available to the first fishery and that F_i is the harvest of tagged fish by fishery i. The removal rate (R) by the first fishery is estimated as follows:

$$R_1 = \frac{F_1}{T_2}$$

For subsequent fisheries where i>1, R_i is estimated as follows:

$$R_i = \frac{F_i}{T_2 \prod_{j=1}^{L} (1-H_j)} \qquad \text{where } L = i-1$$

Removal rates were estimated by gear type (fishery) for the Berners River stock (Table 8) and by area for the Hugh Smith Lake stock (Table 9). Total harvest rate estimates were generated for the Ford Arm Lake stock (Table 4), but removal rate estimates for individual areas and fisheries were not made because most of the catch occurred in outside districts with no clearly defined migration through sequential fisheries. The Ford Arm Lake stock was considered to be harvested simultaneously by all fisheries.

Harvest Distribution. The harvest distribution (percent by area and gear type) was estimated for tagged stocks (Tables 10–12). Expanded tag recoveries of a stock in each fishery (F_i) were divided by the sum of expanded fishery recoveries in all fisheries (ΣF_i). Tag recoveries from the Alaska troll fishery were expanded by PMFC area (Appendix A.2) and fishing period, while recoveries from the net and trap fisheries were expanded by district and statistical week. In addition, the distribution of the Southeast Alaska troll catch of the three stocks was estimated using quadrant-period strata (Table 13).

Migratory Timing. The migratory timing of the three stocks in troll fishing districts was estimated from the distribution of the harvest of tagged fish, by week. Troll fishery tag recoveries were expanded to total catch by quadrant and week. The weekly proportion of the total troll catch of each stock was estimated for each year when data was available (Appendixes B.1–B.3). Expanded weekly recoveries were divided by the sum of expanded recoveries from throughout the

season to estimate weekly proportions of total catch. These estimates were based on the dates of landing of tagged fish at fishing ports. Since the average trip length for a troll vessel was about six days, the average time of capture of landed fish probably occurred three days previously.

Survival Rates. Survival rates were estimated for tagged coho salmon smolts that migrated from Hugh Smith Lake in 1983-1989 and juvenile coho salmon that were tagged in the Berners River (1980-1981, 1983-1988), and at Ford Arm Lake (1980-1981, 1983-1987) (Table 14).

It was assumed that all marked adults returning to a system had been tagged as juveniles or smolts and that there was no incidence of naturally missing adipose fins. Therefore, all adipose clipped fish that did not contain tags were assumed to have shed their tags. A sample of adipose clipped fish (m_2) was drawn from the escapement and sampled for coded-wire tags, of which t fish were found to be tagged. The survival rate from the time of tagging (smolt or age 1+ juvenile) to the adult stage (age .1) was estimated as follows:

$$Survival\ Rate\ (S) = \frac{(\sum F_i + E)\left(\frac{m_2}{t}\right)}{T_1}$$

where m_2 = number of adipose clipped fish in the escapement that were examined for tags

t = number of sampled adipose clipped fish in the escapement that contained tags

T_1 = number of smolts or juveniles tagged

Typically, 90% or more of recoveries from juvenile tag groups have been recovered in a single return year, while virtually all tagged smolts have returned in a single year. Tag retention was assumed to be the same in fish from a single return year because it was impossible to determine when adipose clipped fish without tags had been marked. Potential bias occurs in the estimates to the extent that different tag retention rates have occurred in releases from different years.

Smolt Migration Estimates. Smolt migration estimates from Hugh Smith Lake (1983-1990) and the Berners River (1989 and 1990) were made using a Chapman estimate (Table 15). The number marked (M) was the number of smolts that were adipose clipped and released as they migrated from the system in year i, regardless of whether or not they retained their coded-wire tags. The recovery sample (C) was the sum of the number of age .0 fish sampled for ad clips at the weir in year i, and the number of age .1 fish sampled for ad clips at the weir in year i+1. The number of marks recovered (R) was the number of adipose clipped fish observed in the recovery sample.

Results

Harvest by Gear Type and Escapement

During 1982, 1983 and 1985-1990, the total return to the Berners River in lower Lynn Canal averaged an estimated 24,551 fish (range 14,058-34,036; Table 4). The estimated contribution to the Alaska troll fishery and the Lynn Canal drift gill net fishery averaged 11,638 (range 5,926-17,153) and 6,492 (range 1,664-10,568), respectively. Estimated total contributions to the purse seine and marine sport fisheries averaged only 66 fish and 129 fish, respectively. The estimated total contribution to all fisheries averaged 18,325 fish (range 10,798-24,196) while the total escapement survey count averaged 6,226 (range 1,752-11,050). The troll fishery accounted for an estimated average of 47.7% (range 39.6-55.1%) of the total return while the estimated harvest rate by the drift gill net fishery averaged 26.8% (8.5-41.0%). The purse seine and marine sport fisheries accounted for harvest rates of only 0.3% and 0.5%, respectively. These harvest percentages are likely biased upward because escapement estimates are based on an intensive survey count rather than a total weir count or mark-recapture estimate.

The estimated total return to Ford Arm Lake on the outer coast of Chichagof Island averaged 5,060 fish (range 3,229-6,287) during 1982, 1983 and 1985-1990 (Table 5). Tag recovery data indicated that the Ford Arm Lake stock was harvested by only the troll and purse seine fisheries with average estimated contribution rates of 2,674 (range 1,456-3,777) and 190 (range 0-931), respectively. The estimated total fishery contribution averaged 2,864 (range 1,535-4,343), while the total escapement averaged 2,196 (range 1,546-3,028). The troll harvest rate on Ford Arm Lake coho salmon averaged 52.4% (range 41.3-61.5%), while the purse seine fishery accounted for an average of 3.4% (range 0-14.8%) of the total return.

The total return to Hugh Smith Lake in Boca de Quadra southeast of Ketchikan, averaged an estimated 3,528 fish (range 1,530-6,096) during 1982-1990 (Table 6). The fisheries accounted for an estimated average total catch of 2,344 fish (range 1,017-3,952) and accounted for an average total harvest rate of 66.2% (range 52.3-82.1%). The harvest of Hugh Smith Lake coho salmon was distributed across a variety of fisheries. On the average, an estimated 44.7% of the total return was harvested by troll gear, of which 36.4% was taken in Alaska and 8.3% was taken in British Columbia. An estimated average of 11.5% and 8.3%, respectively, of the total return was harvested by Alaska purse seine and drift gill net fisheries, while 1.1% was harvested by B.C. net fisheries. An average of 0.3% of the estimated total return was harvested by each the Ketchikan marine sport fishery and the Annette Island fish traps. However, sport contribution data is incomplete before 1986 because of inadequate sampling during parts of the season. Overall, Alaska fisheries harvested an estimated average of 56.8% of the total return to Hugh Smith Lake compared with 9.4% for B.C. fisheries. Total harvest rate estimates increased substantiallly from a relatively stable range of 52.3-66.5% in 1982-1988 to 82.1% in 1989 and 81.1% in 1990. Increased harvest rates appeared to have occurred in all of the three major harvesting fisheries (troll, purse seine and drift gill net).

Removal Rates

Removal rate estimates for the Berners River are biased upward because foot surveys on that system provide a less thorough accounting of the escapement compared with total weir counts or mark-recapture estimates on other systems. The Berners River stock is considered to migrate through the troll and purse seine fisheries and then through the Juneau sport fishery before entering Lynn Canal. During 1982, 1983 and 1985-1990, the estimated combined troll and purse seine removal rate for the Berners River stock averaged 0.480 (range 0.408-0.551; Table 8). Because of its late migratory timing (see section on migratory timing), the Berners River stock was subjected to only minor fishing pressure in purse seine and marine sport fisheries. The estimated removal rate in the Juneau marine sport fishery averaged only 0.010. On the average, the Berners River stock was estimated to incur the greatest and most variable removal rate in the Lynn Canal (District 115) drift gill net fishery, with annual estimates averaging 0.513 (range 0.155-0.836).

Coho salmon returning to Hugh Smith Lake are considered to be harvested simultaneously in northern B.C. and the outside and intermediate districts of Southeast Alaska before becoming available in inside waters of southern Southeastern. During 1982-1990, the combined removal rate estimate for Hugh Smith Lake coho salmon in northern B.C. and the outside and intermediate areas of Southeast Alaska averaged 0.441 (range 0.356-0.551) of which 0.346 (0.279-0.458) was attributed to Alaska fisheries, and 0.094 (0.051-0.185) was attributed to northern B.C. fisheries (Table 9). The estimated removal rate in inside areas averaged 0.404 (range 0.247-0.636), while the estimated total harvest rate for all fisheries averaged 0.662 (range 0.523-0.821).

Harvest Distribution

The harvest of the Berners River coho salmon stock was restricted largely to northern fishing areas (Northern Outside, Central Outside, Central Intermediate, Lynn Canal, Stephens Passage) which accounted for an estimated average of 98.8% of the catch during 1982, 1983 and 1985-1990 (Table 10). Small percentages (less than 1%) were taken in the Southern Outside area, Southern Intermediate area, Prince William Sound and northern B.C. Overall, Lynn Canal was the most important single harvest area for the Berners River stock, accounting for an estimated average of 36.8%. The most important harvest areas in the troll and purse seine fisheries were the Northern Outside area (north of Cape Spencer; 23.0%) and the Central Intermediate area (Icy Strait and Cross Sound; 27.5%).

The Ford Arm Lake coho salmon stock on the central outside coast was harvested primarily in the local Central Outside area which accounted for an average of 70.3% of the estimated catch (Table 11). Other important locations where Ford Arm Lake coho salmon were harvested included the Northern Outside and Central Intermediate areas with 20.2% and 6.4%, respectively. In addition, a minor harvest was estimated to have occurred in the Southern Outside (2.0%), Southern Intermediate (0.4%), Central Inside areas (0.6%), and in northern British Columbia (0.1%).

Hugh Smith Lake coho salmon were harvested over a relatively broad area from Yakutat to northern British Columbia. During 1982-1990, the two most important

harvest areas were, on the average, the local Southern Inside area which accounted for an estimated average of 27.8% of the catch, and the Central Outside area which accounted for 25.8% (Table 12). Significant catch also occurred in the Southern Outside area (17.8%), the Southern Intermediate area (5.4%) and northern B.C. (13.9%). Hugh Smith Lake coho salmon were also harvested in the Northern Outside area (4.2%), the Central Intermediate area (1.7%), and the Central Inside area (3.4%).

The harvest distribution of the Southeast Alaska troll catch of selected stocks was estimated by quadrant (Appendix A.2). Nearly all of the estimated troll catch of Berners River and Ford Arm Lake coho salmon occurred in the Northwest Quadrant with average estimates of 97.4% and 98.3%, respectively (Table 13). Hugh Smith Lake fish were more evenly distributed over the quadrants with the following average distribution: Northwest 55.8%; Northeast 6.5%; Southwest 18.6%; Southeast 19.1%.

Migratory Timing

Although it was available to some extent during most of the season, the Berners River stock was characteristically late in migratory timing to all fisheries. It peaked in the troll fishery during late August through mid-September (Figure 4; Appendix B.1). The average period of greatest harvest (more than 10% per week) occurred during approximately August 17 - September 13, while the peak weekly harvest occurred at the beginning of September. On the average, the troll harvest of all coho salmon stocks combined peaked during late July and had declined substantially before the Berners River stock began to peak. Part of the reason for the decline in total troll catch and the low catch of Berners River fish during early to mid-August was implementation of annual 10-day troll closures during that period since 1980.

The Ford Arm Lake stock was characterized by relatively protracted timing in the troll fishery with significant weekly catches occurring from the first week of July through the first week of September (Figure 4; Appendix B.2).

Hugh Smith Lake coho salmon were available to the Alaska troll fishery from late June through the end of the season on 20 September during 1982-1990 (Figure 5; Appendix B.3). The peak typically occurred in mid to late August. Significant differences existed in the timing of the Hugh Smith Lake stock in intermediate and outer coastal areas compared with inside waters. In the Northeast, Northwest and Southwest Quadrants, it underwent significant harvest from mid-July through early September, with a peak contribution in late August (Figure 6; Appendix B.4). However, in inside waters of southern Southeast (Southeast Quadrant), it displayed substantially later timing compared with the total troll harvest of coho salmon (Figure 6; Appendix B.5). In the Southeast Quadrant, the Hugh Smith Lake stock was most heavily harvested during the last week of August through the second week of September, while the total catch of all stocks peaked during the second half of July.

Survival Rates

The estimated survival rate for Hugh Smith Lake smolts that outmigrated in 1982-89 averaged 10.7% with a range of 4.2-19.1% (Table 14). If it is indicative of other systems, the high degree of variability observed in smolt survival rates at Hugh Smith Lake may be sufficient to explain the majority of the variability inherent in returns and catches of coho salmon in southern Southeast.

Survival rate estimates for predominantly age 1+ rearing juveniles tagged at the Berners River during the second half of June have averaged 5.3% (range 2.9-8.8%). Ford Arm Lake rearing juveniles tagged during July and August have experienced high survival rates ranging from 6.0-14.4% and averaging 9.5%.

Smolts that were captured in trough traps in the Berners River in 1989 survived at an estimated rate of 19.8%. Fish from the same outmigrant year that were tagged as presmolts in 1988 survived at an estimated rate of 8.8%. This suggests a freshwater survival rate during the 11 month period from late June 1988 until late May 1989 of about 44%. Fish that were captured in minnow traps in spring 1989 and identified as smolts based on visual characteristics survived at an estimated rate of 20.5% which was slightly higher than trough trap smolts. Fish from the same catches that did not have strong smolt characteristics returned at a rate of 13.1% in 1989, suggesting that a large proportion were smolts despite their appearance.

Smolt Estimates

During 1983-1990, total coho smolt estimates for Hugh Smith Lake averaged 31,046 (range 21,878-51,789). Annual estimates with confidence limits are shown in Table 15. Hugh Smith Lake smolts were predominantly age 2.0 (average 59.6%) while ages 3.0 and 1.0 were also important at 24.5% and 15.1%, respectively (Table 16). Age 4.0 and 5.0 smolts were present but uncommon. Smolt migration estimates by year of migration are shown in Tables 17. The estimated smolt migration by brood year was 33,351 for 1981, 23,822 for 1982, 28,983 for 1983 and 29,548 for 1984 (Table 18). The smolt estimate for the 1985 brood year (excluding age 5.0 migrants) was 24,988, while the smolt estimate for the 1986 brood year (excluding age 4.0 and 5.0 migrants) was 23,480.

The smolt migration from the Berners River in 1989 was estimated at 164,357 fish (95% C.I. 123,645-205,069). The age composition of migrants captured from lower river ponds was 35.6% age 1.0, 60.9% age 2.0, and 3.5% age 3.0 (n=603).

The 1990 smolt migration from the Berners River was estimated at 141,176 fish (95% C.I. 126,291-156,061). The age composition of migrants captured from lower river ponds was 23.8% age 1.0, 74.3% age 2.0, 1.8% age 3.0 and 0.1% age 4.0 (n=869).

DISCUSSION

A primary objective of the indicator stock program has been to track harvest rates, particularly in the more mixed-stock fisheries such as the troll fishery. Harvest rate estimates for the three indicator stocks by the Alaska troll fishery followed a stable trend from 1982-90, with an overall average of 45%. The stability of troll harvest rates reflects a consistent management pattern. Except in 1988, the troll fishery was conducted from early July through September 20 with only a single 10-day closure during late July or August. The average troll harvest rate reached a low of 38% in 1988 when 13 additional days of region-wide closures were added to protect a very weak overall return, and southern Southeast remained closed throughout September.

Average total harvest rate estimates for the three indicator stocks were 56% for the outer coastal stock (Ford Arm Lake), 66% for the southern inside stock (Hugh Smith Lake), and 75% for the Lynn Canal stock (Berners River).

The question of what harvest rates are optimum for coho stocks is central to improvement of management of mixed stock fisheries where strict escapement management is not feasible. There is evidence that harvest rates over 75% are excessive for some groups of wild stocks. Under exploitation rates of 75-80%, both escapements and catches of coho stocks in Georgia Strait, British Columbia have undergone a long-term decline since the early 1970's that has been attributed to over-fishing (Canada Department of Fisheries and Oceans 1990). Based on the current trend for Georgia Strait stocks, supported by simulation modeling with a coho production model for the Carnation Creek stock, Canadian resource planners are recommending that the total harvest rate be reduced to 65-70%. Studies of ten Southeast Alaska stocks in the early 1980's (Shaul et al. *In Press*) indicated that, while harvest rates varied substantially by geographical area, the overall harvest rate averaged about 60%. The upward trend in catches of wild stocks in Southeast Alaska since the early 1980's suggests that this harvest rate is sustainable. Until further information on stock productivity is available, I recommend an upper limit of 70% as a guideline for stocks that are harvested entirely by mixed-stock fisheries. Recent harvest rates of over 80% for the Hugh Smith Lake stock raise concern about the potential for over-exploitation of southern inside stocks. Estimates for 1989 and 1990 were 82% and 81%, respectively, compared with 52-66% (average 62%) in 1982-88. If this trend continues, it will indicate a need for more conservative management of directed fisheries for coho salmon that harvest southern inside stocks. It also points out the need for additional coded-wire tagged indicator stocks and a strong escapement assessment program for this important stock group.

The high average harvest rate estimate (75%) for the Berners River stock is of less concern because a large proportion of the harvest of Lynn Canal stocks occurs in a semi-terminal fishery where abundance of this specific stock group can be assessed and managed for in-season using a historical fishery performance data base. Escapement rather than harvest rate is a more appropriate management objective for stocks in Lynn Canal and the Taku River. Priorities for further assessment projects for northern inside stocks should focus on estimating escapement in the largest producing systems including the Chilkat and Taku Rivers.

The effect that variations in drift gill net fishery removal rates can have on escapements in Lynn Canal is apparent when comparing the 1986 and 1989 returns. Total return estimates in 1986 and 1989 were 24,635 and 19,688, respectively, while the troll fishery harvest rates were close to the same at 55.1% and 53.4%. However, drift gill net removal rates were estimated at 0.836 in 1986 and 0.155 in 1989, while resulting escapements were 1,752 and 7,509, respectively.

A second major objective of the indicator stock program has been to investigate the relationship between escapement and yield, and to better determine an appropriate level of exploitation for wild coho stocks. At Hugh Smith Lake, five years of age-.1 coho salmon escapements ranging from 903 to 2,144 produced a narrow range of estimated smolt migrations (23,480-29,548). No relationship between escapement and smolt production was evident from visual interpretation of this limited data. Smolt production estimates for the relatively low 1988 and 1989 escapements of 513 spawners and 424 spawners, respectively, may help better define the relationship between escapement and resultant production.

Recent results continue to support earlier conclusions about the relative stability of coho production from some lake systems and the important effect of marine survival rates on adult production (Shaul et al. *In Press*). Determination of spawner-recruit relationships for the Hugh Smith Lake stock and the other indicator stocks will require several more years of production estimates from a broader range of escapements.

LITERATURE CITED

Canada Department of Fisheries and Oceans. 1990. Strait of Georgia coho resource status and management planning process. Canada Department of Fisheries and Oceans, Vancouver, B.C.

Chapman, D.G. 1951. Some properties of the hypergeometric distribution with applications to zoological censuses. Univ. Calif. Public. Stat. 1: 131-160.

Clark, J.E. and D.R. Bernard. 1987. A compound multivariate binomial hypergeometric distribution describing coded microwire tag recovery from commercial salmon catches in Southeastern Alaska. Alaska Department of Fish and Game, Division of Commercial Fisheries, Technical Data Report 202, Juneau.

Clutter, R. and L. Whitesel. 1956. Collection and interpretation of sockeye salmon scales. Bulletin of the International Pacific Salmon Fisheries Commission No. 9, New Westminster, British Columbia, Canada.

Elliott, S.T. and K.J. Kuntz. 1988. A study of coho salmon in Southeast Alaska: Chilkat Lake, Chilkoot Lake, Yehring Creek and Vallenar Creek. Alaska Department of Fish and Game, Sport Fish Division, Fishery Data Series No. 62, Juneau.

Gray, P.L., K.R. Florey, J.F. Koerner, and R.A. Marriott. 1978. Coho salmon (*Oncorhynchus kisutch*) fluorescent pigment mark-recovery program for the Taku, Berners, and Chilkat Rivers in Southeastern Alaska (1972- 1974). Alaska Department of Fish and Game, Division of Commercial Fisheries, Information Leaflet 176, Juneau.

Gray, P.L. and R.A. Marriott. 1986. Rearing coho salmon (*Oncorhynchus kisutch*) surveys of 16 Southeastern Alaska watersheds. Alaska Department of Fish and Game, Division of Commercial Fisheries, Technical Data Report 173, Juneau.

INPFC (International North Pacific Fisheries Commission). 1963. Annual Report 1961.

Koerner, J.F. 1977. The use of the coded-wire tag injector under remote field conditions. Alaska Department of Fish and Game, Division of Commercial Fisheries, Informational Leaflet 172, Juneau.

Schaefer, M.B. 1951. Estimation of the size of animal populations by marking experiments. U.S. Fish and Wildlife Service, Fisheries Bulletin 69: 191-203.

Shaul, L. D., P. L. Gray, and J. F. Koerner. 1985. Coded-wire tagging of wild coho (*Oncorhynchus kisutch*) stocks in Southeastern Alaska, 1982-1983. Alaska Department of Fish and Game, Division of Commercial Fisheries, Technical Data Report 140, Juneau.

LITERATURE CITED (Continued)

Shaul, L. D., P. L. Gray, and J. F. Koerner. 1986. Coded-wire tagging of wild coho (*Oncorhynchus kisutch*) stocks in Southeastern Alaska, 1983-1984. Alaska Department of Fish and Game, Division of Commercial Fisheries, Technical Data Report 192, Juneau.

Shaul, L.D., P.L. Gray and J.F. Koerner. In Press. Coded-wire tag estimates of abundance, harvest, and survival rates of selected coho salmon stocks in southeast Alaska, 1981-86. Alaska Department of Fish and Game, Division of Commercial Fisheries, Fishery Research Bulletin, Juneau.

Suchanek, P.M. and A.E. Bingham. 1991. Harvest estimates for selected marine boat sport fisheries in Southeast Alaska in 1989. Alaska Department of Fish and Game, Division of Sport Fish, Fishery Data Series No. 91-48, Juneau.

Wood, D. S. In press. Abundance, age, sex and size of coho salmon (*Oncorhynchus kisutch* Walbaum) catches and escapements in Southeast Alaska, 1989. Alaska Department of Fish and Game, Division of Commercial Fisheries, Technical Fishery Report, Juneau.

Table 1. Number of Berners River coho salmon tagged by year, type and tag code, 1972-91.

Year	Type	Code		Number Marked
1972	Presmolt	Fluorescent pigment		8,066
1976	Presmolt	4-02-15		10,817
		4-03-08		526
			Total	11,343
1977	Presmolt	4-16-37		380
		4-17-29		10,758
			Total	11,138
1980	Presmolt	4-20-15		10,145
		4-20-30		780
			Total	10,925
1981	Presmolt	4-19-21		7,826
1983	Presmolt	4-22-08		1,278
		4-22-43		9,070
			Total	10,348
1984	Presmolt	4-24-34		4,499
		4-24-36		10,827
			Total	15,326
1985	Presmolt	4-24-46		10,110
1986	Presmolt	4-23-05		8,740
1987	Presmolt	4-26-56		10,349
1988	Presmolt	4-29-42		9,926
1989	Smolt (trough trap)	4-29-27		6,438
	Smolt (minnow trap)	4-29-23		1,021
	Mixed (minnow trap)	4-29-26		5,660
			Total	13,119
1990	Smolt (trough trap)	4-26-62		11,478
	Smolt (trough trap)	4-29-31		10,540
	Smolt (trough trap)	4-31-05		1,580
	Mixed (minnow trap)	4-26-61		2,781
			Total	26,379
1991	Smolt (trough trap)	4-29-44		21,456
	Smolt (minnow trap)	4-31-06		1,414
	Mixed (minnow trap)	4-31-10		3,669
			Total	26,539

Table 2. Number of presmolt coho salmon tagged at Ford Arm Lake by year and code, 1980-91.

Year	Code		Number Marked
1980	4-20-21		5,925
	4-20-24		444
		Total	6,369
1981	4-21-23		4,914
	4-21-33		2,012
		Total	6,926
1983	4-23-23		3,882
1984	4-23-28		2,033
	4-24-35		5,629
		Total	7,662
1985	4-24-47		7,626
1986	4-23-03		10,392
1987	4-26-57		10,138
1988	4-29-22		11,108
	4-29-18		1,459
		Total	12,567
1989	4-29-41		11,300
1990	4-33-54		10,742
1991	4-36-38		9,506

Table 3. Number of coho salmon coded-wire tagged at Hugh Smith Lake by year, type and code, 1980-91.

Year	Type	Code	Number Tagged
1980	Presmolt	4-20-16	5,345
1981	Smolt	4-20-18	2,777
	Presmolt	4-20-20	3,737
		Total	6,514
1982	Smolt	4-21-30	4,873
	Smolt	4-21-43	700
		Total	5,573
1983	Smolt	4-20-28	2,489
	Smolt	4-20-29	1,289
	Smolt	4-22-06	5,869
		Total	9,647
1984	Smolt	4-23-06	5,227
	Smolt	4-23-07	1,576
	Smolt	4-23-19	9,944
		Total	16,747
1985	Smolt	4-24-50	5,352
	Smolt	4-24-51	3,102
	Smolt	4-24-52	1,379
		Total	9,833
1986	Smolt	4-24-41	5,689
1987	Smolt	4-26-52	4,806
1988	Smolt	4-29-24	5,202
1989	Smolt	4-27-18	7,187
1990	Smolt	4-27-20	10,187
	Smolt	4-29-19	919
		Total	11,106
1991	Smolt	4-36-02	12,068
	Smolt	4-35-52	1,201
		Total	13,269

Table 4. Estimated harvest and percent by gear type, escapement, and total return of coho salmon returning to the Berners River, 1982, 1983 and 1985-1990.

Year	Fishery Sample Size[a]	Harvest: Number of fish and percent by gear type					Escapement	Total Return
		Troll	Purse Seine	Drift Gill Net	Sport	Total Catch		
1982	48	12,887 (41.6%)	0	10,568 (34.1%)	0	23,455 (75.7%)	7,505 (24.3%)	30,960 (100%)
1983	125	17,153 (50.4%)	0	6,978 (20.5%)	65 (0.2%)	24,196 (71.1%)	9,840 (28.9%)	34,036 (100%)
1985	93	10,865 (44.8%)	198 (0.8%)	7,015 (28.9%)	0	18,078 (74.5%)	6,169 (25.5%)	24,247 (100%)
1986	157	13,560 (55.1%)	0	8,928 (36.2%)	395 (1.6%)	22,883 (92.9%)	1,752 (7.1%)	24,635 (100%)
1987	53	7,448[b] (53.0%)	0	3,301 (23.5%)	48 (0.3%)	10,798 (76.8%)	3,260 (23.2%)	14,058 (100%)
1988	102	5,926 (39.6%)	181 (1.2%)	6,141 (41.0%)	0	12,248 (81.8%)	2,724 (18.2%)	14,972 (100%)
1989	58	10,515 (53.4%)	0	1,664 (8.5%)	0	12,179 (61.9%)	7,509 (38.1%)	19,688 (100%)
1990	470	14,751 (43.6%)	149 (0.4%)	7,339 (21.7%)	525 (1.6%)	22,764 (67.3%)	11,050 (32.7%)	33,814 (100%)
Average Number of Fish		11,638	66	6,492	129	18,325	6,226	24,551
Average Percent of Total		47.7	0.3	26.8	0.5	75.3	24.7	100

[a] Includes only expandable random recoveries.

[b] Estimated troll catch in 1987 includes 242 fish (1.7%) harvested in the northern British Columbia troll fishery. The estimated average number and percent harvested in the Southeast Alaska troll fishery was 11,608 (47.5%).

Table 5. Estimated harvest and percent by gear type, escapement, and total return of coho salmon returning to Ford Arm Lake, 1982, 1983 and 1985-1990.

Year	Fishery Sample Size[a]	Harvest: Number of fish and percent by gear type			Escapement	Total Return
		Troll	Purse Seine	Total Catch		
1982	38	1,948 (41.3%)	106 (2.3%)	2,054 (43.6%)	2,662 (56.4%)	4,716 (100%)
1983	93	3,412 (54.3%)	931 (14.8%)	4,343 (69.1%)	1,944 (30.9%)	6,287 (100%)
1985	49	2,438 (51.2%)	0	2,438 (51.2%)	2,324 (48.8%)	4,762 (100%)
1986	87	2,500 (60.9%)	62 (1.5%)	2,562 (62.4%)	1,546 (37.6%)	4,108 (100%)
1987	71	1,456 (45.1%)	79 (2.4%)	1,535 (47.5%)	1,694 (52.5%)	3,229 (100%)
1988	151	2,887[b] (48.4%)	46 (0.8%)	2,933 (49.2%)	3,028 (50.8%)	5,961 (100%)
1989	221	3,777 (61.5%)	185 (3.0%)	3,962 (64.5%)	2,177 (35.5%)	6,139 (100%)
1990	174	2,979 (56.5%)	108 (2.0%)	3,087 (58.5%)	2,190 (41.5%)	5,277 (100%)
Average Number of Fish		2,674	190	2,864	2,196	5,060
Average Percent of Total		52.4	3.4	55.8	44.2	100

[a] Includes only expandable random recoveries.

[b] Estimated troll catch in 1988 included 30 fish (0.5%) harvested in the northern British Columbia troll fishery. The estimated average number and percent harvested in the Southeast Alaska troll fishery was 2,671 (52.3%).

Table 6. Estimated harvest and percent by gear type, escapement, and total return of coho salmon returning to Hugh Smith Lake, 1982-1990.

Year	Fishery Sample Size[a]	Harvest: Number of fish and percent by gear type									
		Alaska Troll	Alaska Seine	Alaska Gill Net	Alaska Trap	Alaska Sport	B.C. Troll	B.C. Net	Total Catch	Escapement	Total Return
1982	91	2,780 (45.6%)	627 (10.3%)	203 (3.3%)	0	0	264 (4.3%)	78 (1.3%)	3,952 (64.8%)	2,144 (35.2%)	6,096 (100%)
1983	189	1,373 (35.4%)	424 (10.9%)	277 (7.2%)	49 (1.3%)	0	211 (5.4%)	51 (1.3%)	2,385 (61.5%)	1,490 (38.5%)	3,875 (100%)
1984	151	1,260 (31.4%)	501 (12.5%)	470 (11.7%)	18 (0.5%)	0	325 (8.1%)	28 (0.7%)	2,602 (64.9%)	1,408 (35.1%)	4,010 (100%)
1985	212	868 (36.0%)	287 (11.9%)	137 (5.7%)	5 (0.2%)	0	199 (8.3%)	13 (0.5%)	1,509 (62.6%)	903 (37.4%)	2,412 (100%)
1986	257	1,585 (35.4%)	515 (11.5%)	315 (7.0%)	2 (0.1%)	14 (0.3%)	234 (5.2%)	26 (0.6%)	2,691 (60.1%)	1,783 (39.9%)	4,474 (100%)
1987	100	656 (28.0%)	95 (4.1%)	249 (10.6%)	0	23 (1.0%)	153 (6.5%)	50 (2.2%)	1,226 (52.3%)	1,118 (47.7%)	2,344 (100%)
1988	42	408 (26.7%)	230 (15.0%)	122 (8.0%)	0	0	234 (15.3%)	23 (1.5%)	1,017 (66.5%)	513 (33.5%)	1,530 (100%)
1989	91	1,213 (50.0%)	375 (15.5%)	237 (9.8%)	0	41 (1.7%)	105 (4.3%)	20 (0.8%)	1,991 (82.1%)	433 (17.9%)	2,415 (100%)
1990	263	1,810 (39.4%)	538 (11.7%)	504 (11.0%)	24 (0.5%)	0	794 (17.3%)	53 (1.2%)	3,723 (81.1%)	870 (18.9%)	4,593 (100%)
Average Number of Fish		1,328	399	279	11	9	280	38	2,344	1,184	3,528
Average Percent of Total		36.4	11.5	8.3	0.3	0.3	8.3	1.1	66.2	33.8	100

[a] Includes only expandable random recoveries.

Table 7. Estimated harvest rates for three coded-wire tagged indicator stocks by the Alaska troll fishery and by all fisheries combined, 1982-90.

Alaska Troll Fishery

	Stock (Troll Harvest Rate in Percent)			
Year	Berners River	Ford Arm Lake	Hugh Smith Lake	Average
1982	41.6	41.3	45.6	42.8
1983	50.4	54.3	35.4	46.7
1984			31.4	38.8[1]
1985	44.8	51.2	36.0	44.0
1986	55.1	60.9	35.4	50.5
1987	51.3	45.1	28.0	41.5
1988	39.6	47.9	26.7	38.1
1989	53.4	61.5	50.0	55.0
1990	44.0	56.5	48.8	46.5
Average	47.5	52.3	37.5	44.9

All Fisheries

	Stock (Total Harvest Rate in Percent)			
Year	Berners River	Ford Arm Lake	Hugh Smith Lake	Average
1982	75.7	43.6	64.8	61.4
1983	71.1	69.1	61.5	67.2
1984			64.9	64.4[1]
1985	74.5	51.2	62.6	62.8
1986	92.9	62.4	60.1	71.8
1987	76.8	47.5	52.3	58.9
1988	81.8	49.2	66.5	65.8
1989	61.9	64.5	82.1	69.5
1990	66.8	58.5	76.5	69.0
Averag	75.2	55.8	65.7	65.6

[1] The average for 1984 is weighted. The estimate for the Hugh Smith Lake stock in 1984 was divided by its average proportional contribution to the sum of estimates for all three systems during 1982-83 and 1985-90. That number was then divided by the number of stocks (3) to get a weighted average for 1984 that is more comparable with other years than a simple average.

Table 8. Estimated removal rate by fishery for coho salmon returns to the Berners River, 1982, 1983 and 1985-1990.

Year	Troll and Purse Seine	Marine Sport	115 Gill Net	Gill Net and Sport Total	Grand Total
1982	0.416	0	0.585	0.585	0.757
1983	0.504	0.004	0.415	0.417	0.711
1985	0.456	0	0.532	0.532	0.745
1986	0.551	0.036	0.836	0.842	0.929
1987	0.530	0.007	0.503	0.507	0.768
1988	0.408	0	0.693	0.693	0.818
1989	0.534	0	0.155	0.182	0.619
1990	0.440	0.029	0.387	0.415	0.673
Average	0.480	0.010	0.513	0.522	0.752

Table 9. Estimated removal rate by area for coho salmon returns to Hugh Smith Lake, 1982-1990.

Year	Outside and Intermediate	Northern B.C.	Total	Inside[a]	Grand Total
1982	0.381	0.056	0.437	0.375	0.648
1983	0.289	0.067	0.356	0.403	0.615
1984	0.302	0.088	0.390	0.424	0.649
1985	0.318	0.088	0.406	0.370	0.626
1986	0.382	0.058	0.440	0.288	0.601
1987	0.279	0.087	0.366	0.247	0.523
1988	0.343	0.168	0.511	0.314	0.665
1989	0.458	0.051	0.509	0.636	0.821
1990	0.366	0.185	0.551	0.579	0.811
Average	0.346	0.094	0.441	0.404	0.662

[a] Inside area includes Districts 101, 102, 105, 106, 107 and 108.

Table 10. Estimated harvest distribution of Berners River coho salmon by area and gear type, 1982, 1983, and 1985-1990.

Area	Gear Type	Year (Percent) 1982	1983	1985	1986	1987	1988	1989	1990	Avg.
P. W. Sound	Gill Net	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0
Northern Outside	Troll	20.3	29.6	18.3	28.4	16.9	20.3	24.8	25.2	23.0
Central Outside	Troll	3.7	11.7	15.5	15.7	13.9	2.1	11.9	8.4	10.4
Southern Outside	Troll	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.8	0.1
	Seine	0.0	0.0	0.0	0.0	0.0	1.5	0.0	0.2	0.2
	Total	0.0	0.0	0.0	0.0	0.0	1.5	0.0	1.0	0.3
Central Intermediate	Troll	35.6	26.9	23.3	7.7	22.9	25.9	48.8	26.9	27.3
	Seine	0.0	0.0	1.2	0.0	0.0	0.0	0.0	0.4	0.2
	Sport	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0
	Total	35.6	26.9	24.5	7.7	22.9	25.9	48.8	27.5	27.5
Southern Intermediate	Troll	0.0	1.0	0.0	1.5	0.0	0.0	0.0	1.2	0.5
	Seine	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0
	Total	0.0	1.0	0.0	1.5	0.0	0.0	0.0	1.3	0.5
Central Inside	Gill Net	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0
Stephens Passage	Sport	0.0	0.3	0.0	2.0	0.6	0.0	0.0	2.2	0.6
	Gill Net	0.0	0.0	0.0	0.0	0.0	0.0	2.6	1.3	0.5
	Total	0.0	0.3	0.0	2.0	0.6	0.0	2.6	3.5	1.1
Lynn Canal	Troll	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0
	Gill Net	40.4	30.5	41.7	44.7	42.6	50.2	11.9	32.3	36.8
	Total	40.4	30.5	41.7	44.7	42.6	50.2	11.9	32.7	36.8
British Columbia	Troll	0.0	0.0	0.0	0.0	3.1	0.0	0.0	0.4	0.4
Grand Total		100	100	100	100	100	100	100	100	100
Sample Size (Tags)		40	98	81	122	32	103	48	387	

Table 11. Estimated harvest distribution of Ford Arm Lake coho salmon by area and gear type, 1982, 1983 and 1985-1990.

Area	Gear Type	Year (Percent) 1982	1983	1985	1986	1987	1988	1989	1990	Avg.
Northern Outside	Troll	9.4	19.2	15.3	4.9	24.0	29.5	31.2	27.7	20.2
Central Outside	Troll	62.4	51.0	84.7	88.0	55.8	61.8	55.9	63.0	65.3
	Seine	0.0	23.0	0.0	0.7	6.8	0.0	5.9	3.3	5.0
	Total	62.4	74.0	84.7	88.7	62.6	61.8	61.8	66.3	70.3
Southern Outside	Troll	5.3	1.0	0.0	1.2	0.0	0.0	0.0	0.0	0.9
	Seine	5.0	0.0	0.0	1.9	0.0	1.6	0.0	0.0	1.1
	Total	10.3	1.0	0.0	3.1	0.0	1.6	0.0	0.0	2.0
Central Intermediate	Troll	13.0	5.8	0.0	1.3	13.4	5.5	6.4	5.5	6.3
	Seine	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.1
	Total	13.0	5.8	0.0	1.3	13.4	5.5	6.4	6.0	6.4
Southern Intermediate	Troll	0.0	0.0	0.0	2.0	0.0	0.5	0.6	0.4	0.4
Central Inside	Troll	4.9	0.0	0.0	0.0	0.0	0.0	0.0	0.7	0.6
Northern British Columbia	Troll	0.0	0.0	0.0	0.0	0.0	1.1	0.0	0.2	0.1
Grand Total		100	100	100	100	100	100	100	100	100
Sample Size (Tags)		31	71	31	65	49	132	157	134	

Table 12. Estimated harvest distribution of Hugh Smith Lake coho salmon by area and gear type, 1982-1990.

Area	Gear Type	Year (Percent) 1982	1983	1984	1985	1986	1987	1988	1989	1990	Avg.
Northern Outside	Troll	0.0	8.0	5.6	5.8	2.7	3.3	6.7	0.0	6.1	4.2
Central Outside	Troll	30.2	21.6	19.8	33.0	37.9	11.3	23.8	31.2	22.9	25.8
	Seine	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Total	30.2	22.0	19.8	33.0	37.9	11.3	23.8	31.2	22.9	25.8
Southern Outside	Troll	11.1	10.0	7.0	8.6	5.7	22.6	5.6	12.2	7.3	10.0
	Seine	5.2	3.0	8.7	3.0	11.5	5.6	17.1	9.5	6.2	7.8
	Total	16.3	13.0	15.7	11.6	17.1	28.2	22.7	21.7	13.5	17.8
Central Intermed.	Troll	1.4	2.2	6.9	0.0	2.7	1.2	0.0	1.0	0.0	1.7
Southern Intermed.	Troll	10.7	4.4	0.7	2.8	3.9	9.9	3.3	6.9	5.5	5.3
	Seine	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.3	0.1
	Total	10.7	4.4	1.2	2.8	3.9	9.9	3.3	6.9	5.8	5.4
Central Inside	Troll	0.3	2.9	1.2	0.7	1.1	0.0	0.0	5.6	1.2	1.4
	Seine	0.0	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
	Gill Net	0.0	5.5	0.6	0.3	3.2	0.0	0.0	4.2	3.1	1.9
	Total	0.3	9.0	1.8	1.0	4.3	0.0	0.0	9.8	4.3	3.4
Southern Inside	Troll	14.7	9.0	9.4	7.2	4.4	6.0	5.1	5.1	5.5	7.4
	Seine	11.7	13.6	9.2	15.8	7.9	2.0	3.9	8.8	8.0	9.0
	Gill Net	5.5	6.0	16.7	8.6	8.6	20.0	11.1	7.4	10.5	10.5
	Trap	0.0	2.0	0.7	0.4	0.1	0.0	0.0	0.0	0.6	0.4
	Sport	0.0	0.0	0.0	0.0	0.5	1.8	0.0	2.0	0.0	0.5
	Total	31.9	30.6	36.0	32.0	21.5	29.8	20.1	23.3	24.6	27.8
British Columbia	Troll	7.1	8.7	12.0	13.0	8.8	12.3	21.3	5.1	21.4	12.2
	Net	2.1	2.1	1.0	0.8	1.0	4.0	2.1	1.0	1.4	1.7
	Total	9.2	10.8	13.0	13.8	9.8	16.3	23.4	6.1	22.8	13.9
Grand Total		100	100	100	100	100	100	100	100	100	100
Sample Size (Tags)		83	175	143	196	228	99	42	92	258	

Table 13. Estimated distribution by quadrant of the Alaska troll catch of Berners River, Ford Arm Lake and Hugh Smith Lake coho salmon, 1982-1990.

Berners River

Year	Quadrant (Percent) Northwest	Northeast	Southwest	Southeast	Total	Number of Recoveries
1982	100.0	0.0	0.0	0.0	100	25
1983	97.0	3.0	0.0	0.0	100	77
1985	100.0	0.0	0.0	0.0	100	50
1986	96.6	3.4	0.0	0.0	100	87
1987	96.4	3.6	0.0	0.0	100	43
1988	97.6	2.4	0.0	0.0	100	64
1989	97.4	2.6	0.0	0.0	100	49
1990	93.9	5.0	1.1	0.0	100	303
Avg.	97.4	2.5	0.1	0.0	100	

Ford Arm Lake

Year	Quadrant (Percent) Northwest	Northeast	Southwest	Southeast	Total	Number of Recoveries
1982	91.3	0.0	5.8	2.9	100	37
1983	98.8	0.0	1.2	0.0	100	83
1985	100.0	0.0	0.0	0.0	100	49
1986	97.0	1.8	1.2	0.0	100	85
1987	100.0	0.0	0.0	0.0	100	65
1988	99.5	0.5	0.0	0.0	100	148
1989	99.5	0.5	0.0	0.0	100	206
1990	100.0	0.0	0.0	0.0	100	134
Avg.	98.3	0.3	1.0	0.4	100	

Hugh Smith Lake

Year	Quadrant (Percent) Northwest	Northeast	Southwest	Southeast	Total	Number of Recoveries
1982	47.0	14.8	14.8	23.3	100	64
1983	52.1	5.6	17.6	24.6	100	107
1984	59.7	1.3	15.1	23.8	100	67
1985	65.5	2.4	15.2	16.9	100	114
1986	73.9	5.2	9.5	11.4	100	155
1987	31.8	14.8	42.8	10.7	100	52
1988	68.2	0.0	15.6	16.3	100	22
1989	48.4	6.1	20.9	24.6	100	61
1990	55.3	8.3	15.8	20.6	100	123
Avg.	55.8	6.5	18.6	19.1	100	

Table 14. Estimated survival rates of predominantly age 1+ and older wild juvenile coho salmon and smolts from the time of tagging until entry into the fisheries the following year, 1980-1989.

Year Tagged	Survival Rate		
	Berners River Rearing Juveniles	Ford Arm Lake Rearing Juveniles	Hugh Smith Lake Outmigrating Smolts
1980	2.9%	6.3%	-
1981	6.7%	9.6%	-
1982	-	-	13.3%
1983	5.9%	14.4%	7.4%
1984	5.1%	10.2%	7.5%
1985	3.2%	6.0%	19.1%
1986	5.3%	7.0%	10.6%
1987	4.3%	12.7%	4.2%
1988	8.8%	-	6.0%
1989	-	-	17.3%
Average	5.3%	9.5%	10.7%

Table 15. Hugh Smith Lake coho salmon smolt weir counts and total estimates, 1983-1990.

Year	Smolt Weir Count	Number Marked (M)	Returns Sampled (C)	Adipose Clips (R)	Smolt Estimate (N)	Variance	95% C.I. Lower Bound	95% C.I. Upper Bound
1983	27,552	9,647	1,239	230	51,789	9182285	45,850	57,728
1984	22,803	16,928	805	424	32,104	1115047	30,035	34,174
1985	11,111	9,833	692	289	23,499	1071050	21,470	25,527
1986	6,819	5,716	508	132	21,878	2577574	18,732	25,025
1987	4,965	4,819	262	34	36,218	31360356	25,242	47,194
1988	5,319	5,292	290	65	23,336	6206793	18,453	28,219
1989	7,187	7,187	736	198	26,620	2514993	23,512	29,728
1990	11,106	11,106	1,582	533	32,925	1278248	30,709	35,141

Table 16. Estimated proportional age composition of Hugh Smith Lake coho salmon smolts, 1983-1990.

Year	Age 1.0	2.0	3.0	4.0	5.0	Sample Size
1983	0.2230	0.4951	0.2820	0.0000	0.0000	305
1984	0.1227	0.5242	0.3457	0.0074	0.0000	269
1985	0.1794	0.6088	0.2118	0.0000	0.0000	340
1986	0.1601	0.5850	0.2549	0.0000	0.0000	306
1987	0.0575	0.6150	0.3274	0.0000	0.0000	452
1988	0.1610	0.7123	0.1254	0.0014	0.0000	702
1989	0.2603	0.4960	0.2112	0.0297	0.0029	853
1990	0.0466	0.7336	0.1981	0.0201	0.0017	782
Average	0.1513	0.5962	0.2446	0.0073	0.0006	

Table 17. Estimated coho salmon smolt migration from Hugh Smith Lake by age class, 1983-1990.

	Age					
Year	1.0	2.0	3.0	4.0	5.0	Total
1983	11,546	25,640	14,603	0	0	51,789
1984	3,938	16,828	11,099	239	0	32,104
1985	4,216	14,307	4,976	0	0	23,499
1986	3,503	12,798	5,577	0	0	21,878
1987	2,083	22,276	11,859	0	0	36,218
1988	3,756	16,621	2,925	33	0	23,336
1989	6,928	13,203	5,623	789	77	26,620
1990	1,534	24,155	6,521	660	55	32,925
Avg.	4,688	18,228	7,898	215	16	31,046

Table 18. Estimated coho salmon smolt production from Hugh Smith Lake and parent escapement by brood year, 1983-1990.

Brood Year	Escapement	Age 1.0	2.0	3.0	4.0	5.0	Total
1981		11,546	16,828	4,976	0	0	33,351
1982	2,144	3,938	14,307	5,577	0	0	23,822
1983	1,490	4,216	12,798	11,859	33	77	28,983
1984	1,408	3,503	22,276	2,925	789	55	29,548
1985	903	2,083	16,621	5,623	660		24,988
1986	1,783	3,756	13,203	6,521			23,480
1987	1,118	6,928	24,155				
1988	513	1,534					
1989	424						
1990	870						

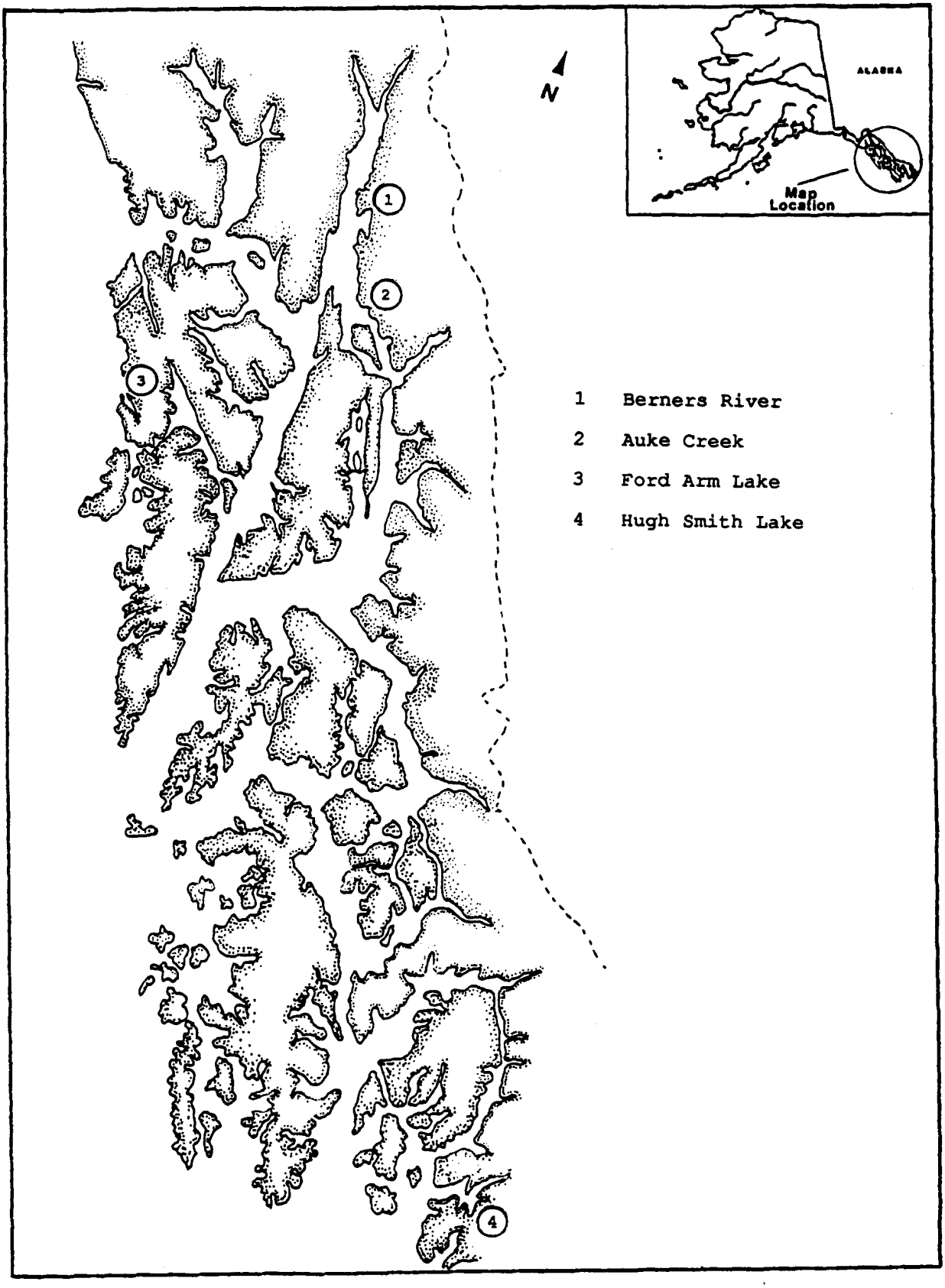


Figure 1. Wild coho salmon coded-wire tag indicator stocks in Southeast Alaska.

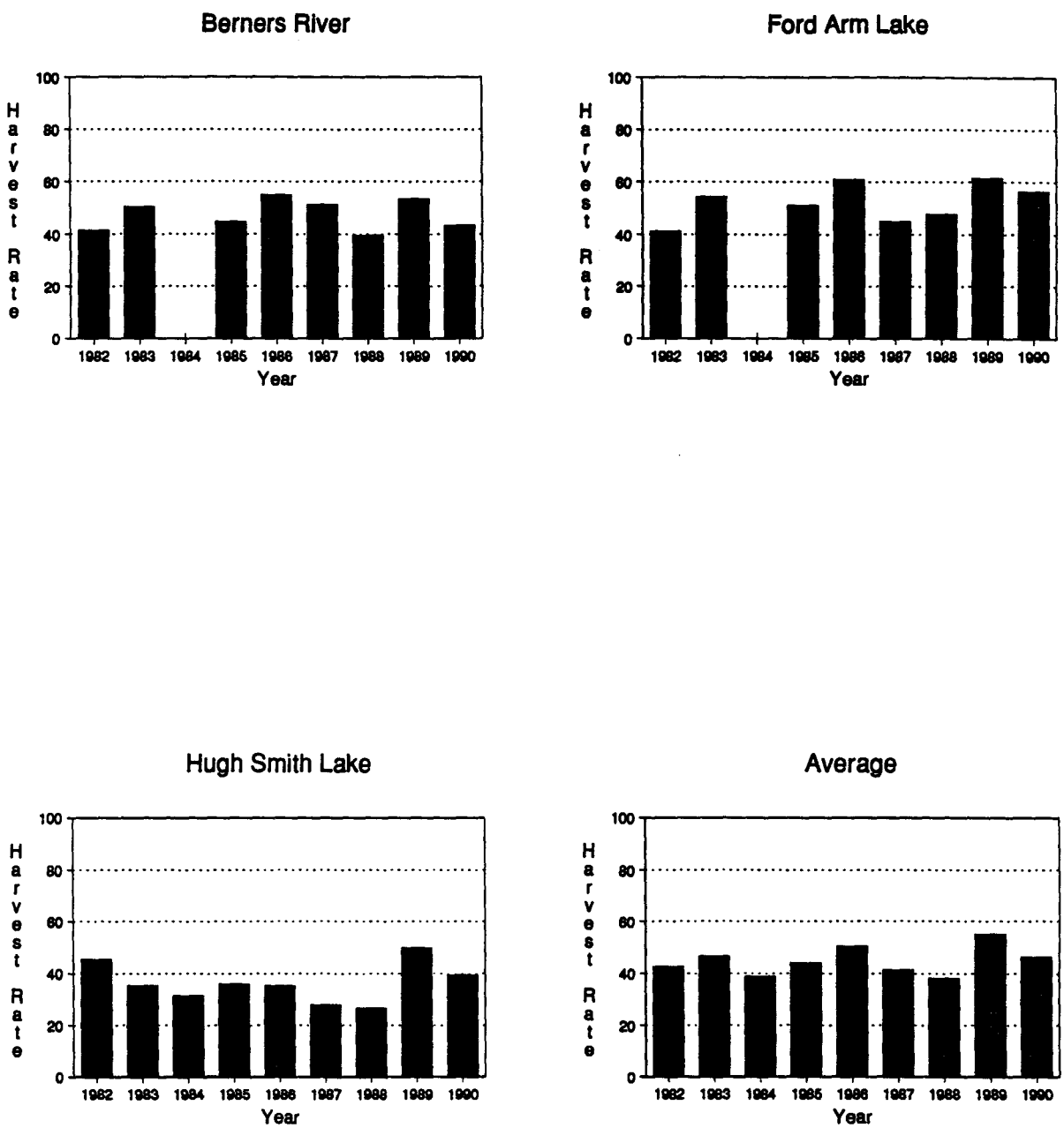


Figure 2. Estimated harvest rates for three coded-wire tagged Southeast Alaska coho salmon stocks by the Alaska troll fishery, 1982-90.

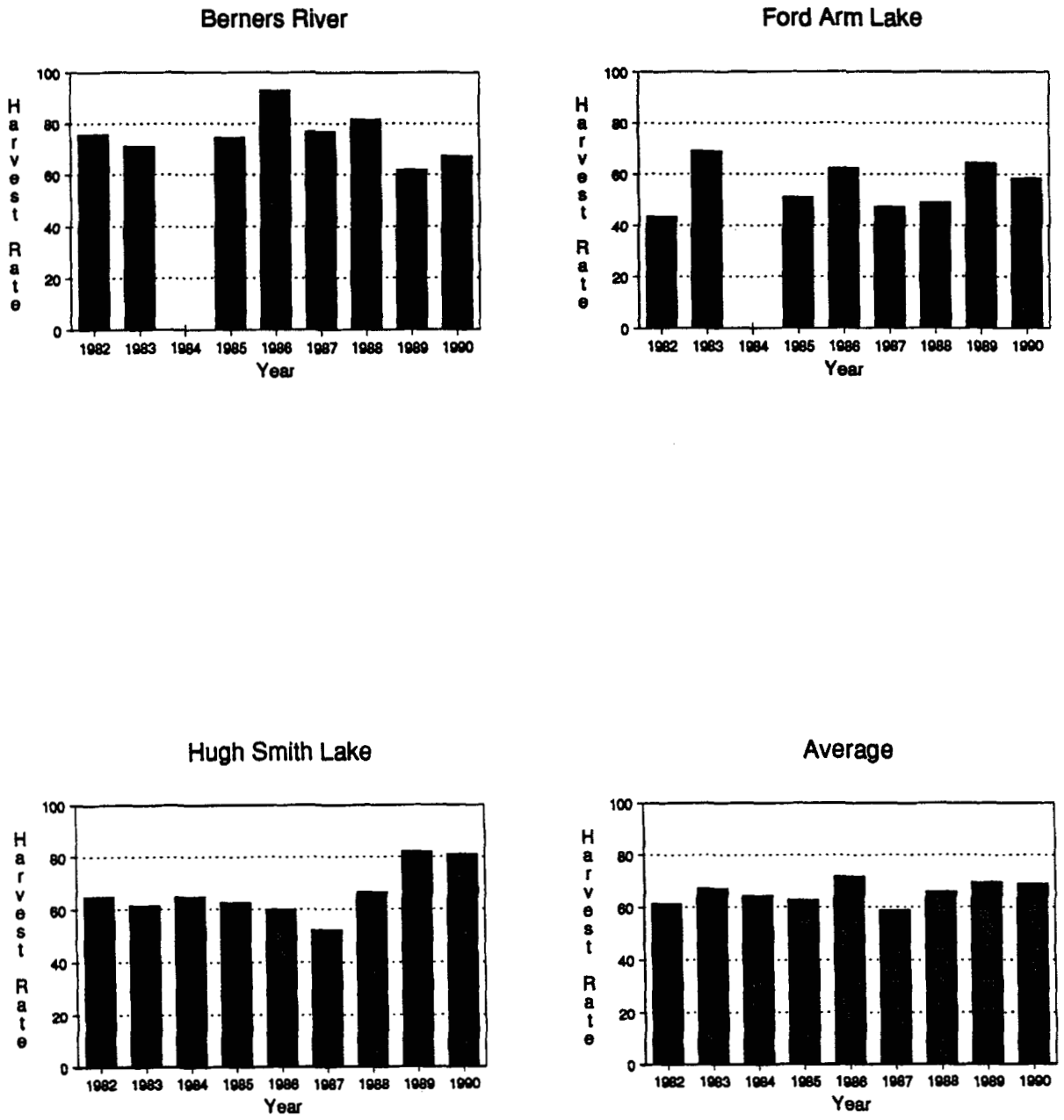


Figure 3. Estimated harvest rates for three coded-wire tagged Southeast Alaska coho salmon stocks by all fisheries, 1982-90.

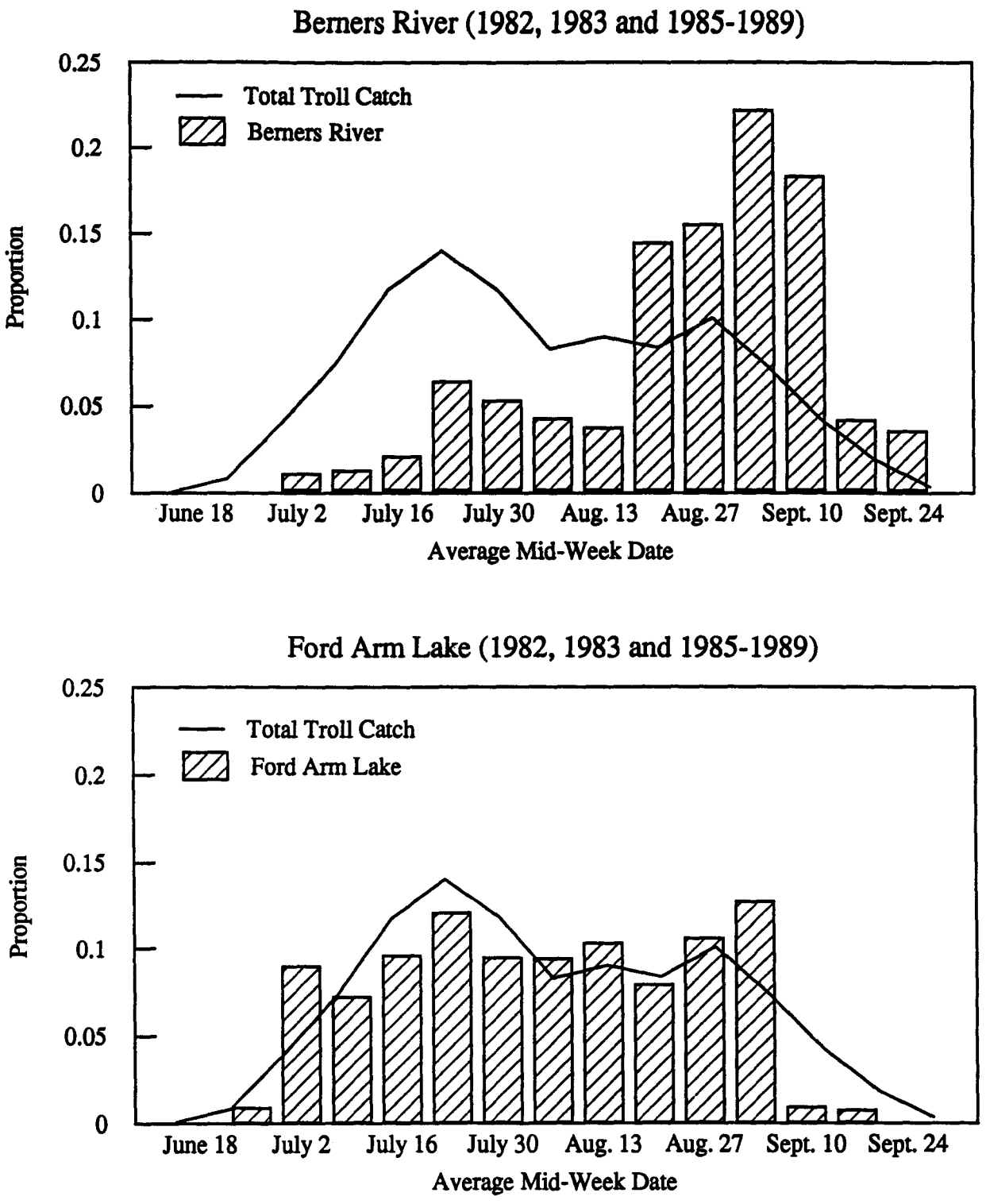


Figure 4. Average weekly proportion of the total coho salmon troll catch (line graph) and estimated troll catch of coded-wire tagged Berners River and Ford Arm Lake coho salmon (bar graph), 1982, 1983 and 1985-1989.

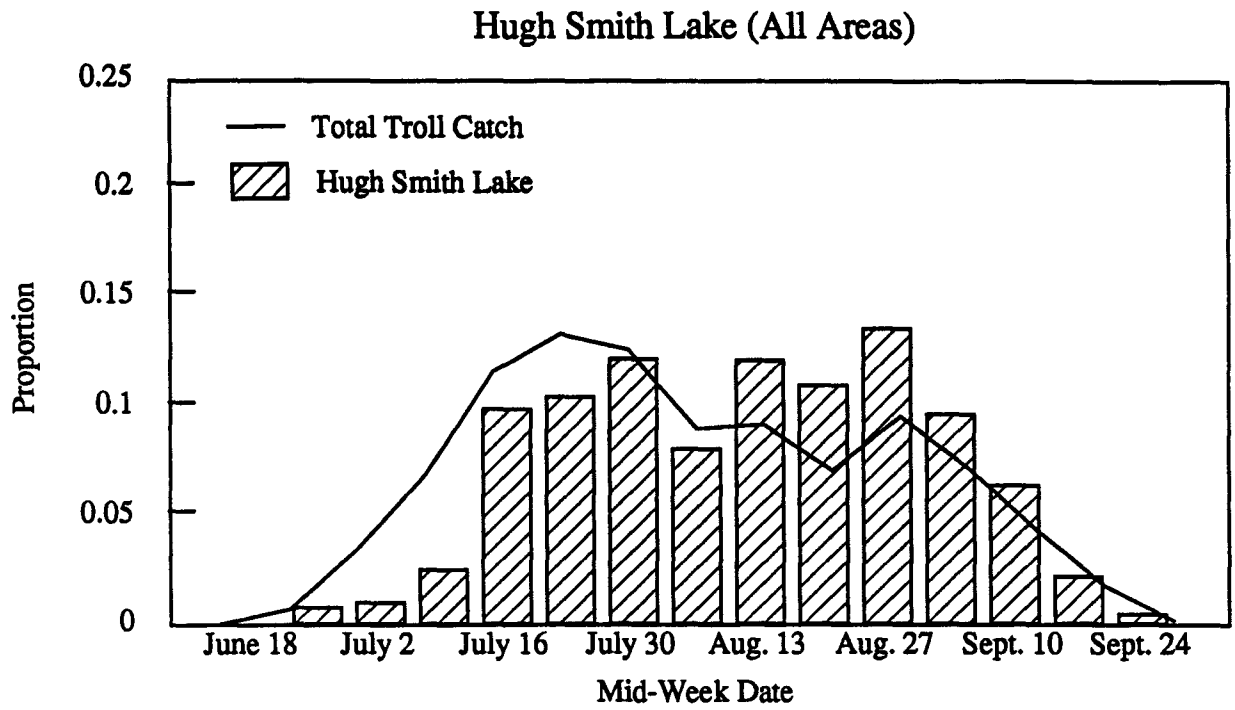
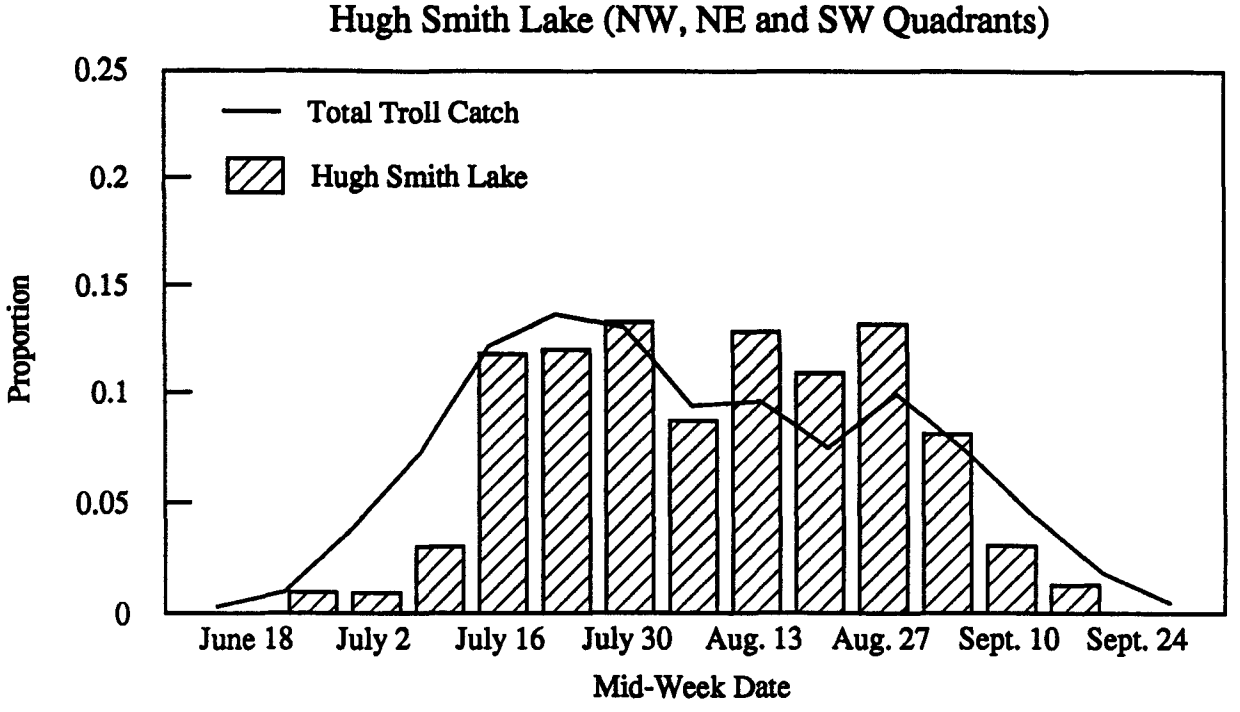


Figure 5. Average weekly proportion of the total coho salmon troll catch (line graph) and estimated troll catch of coded-wire tagged Hugh Smith Lake coho salmon (bar graph), 1982-1990.



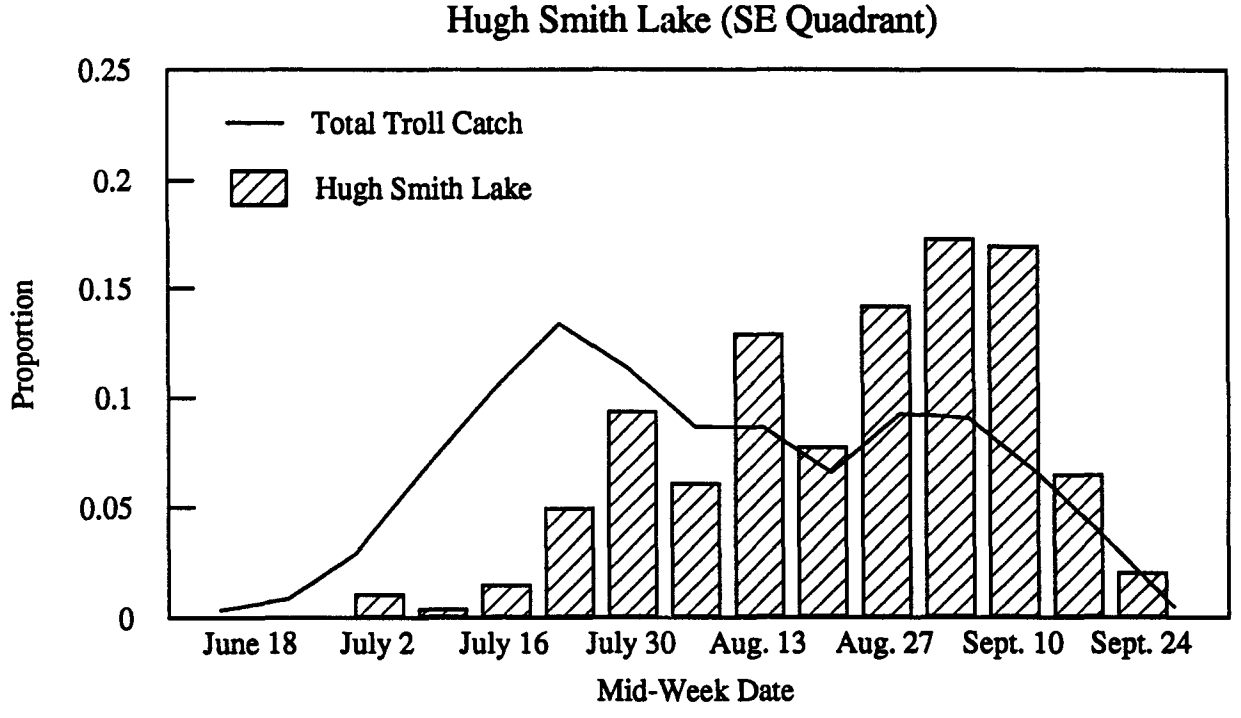
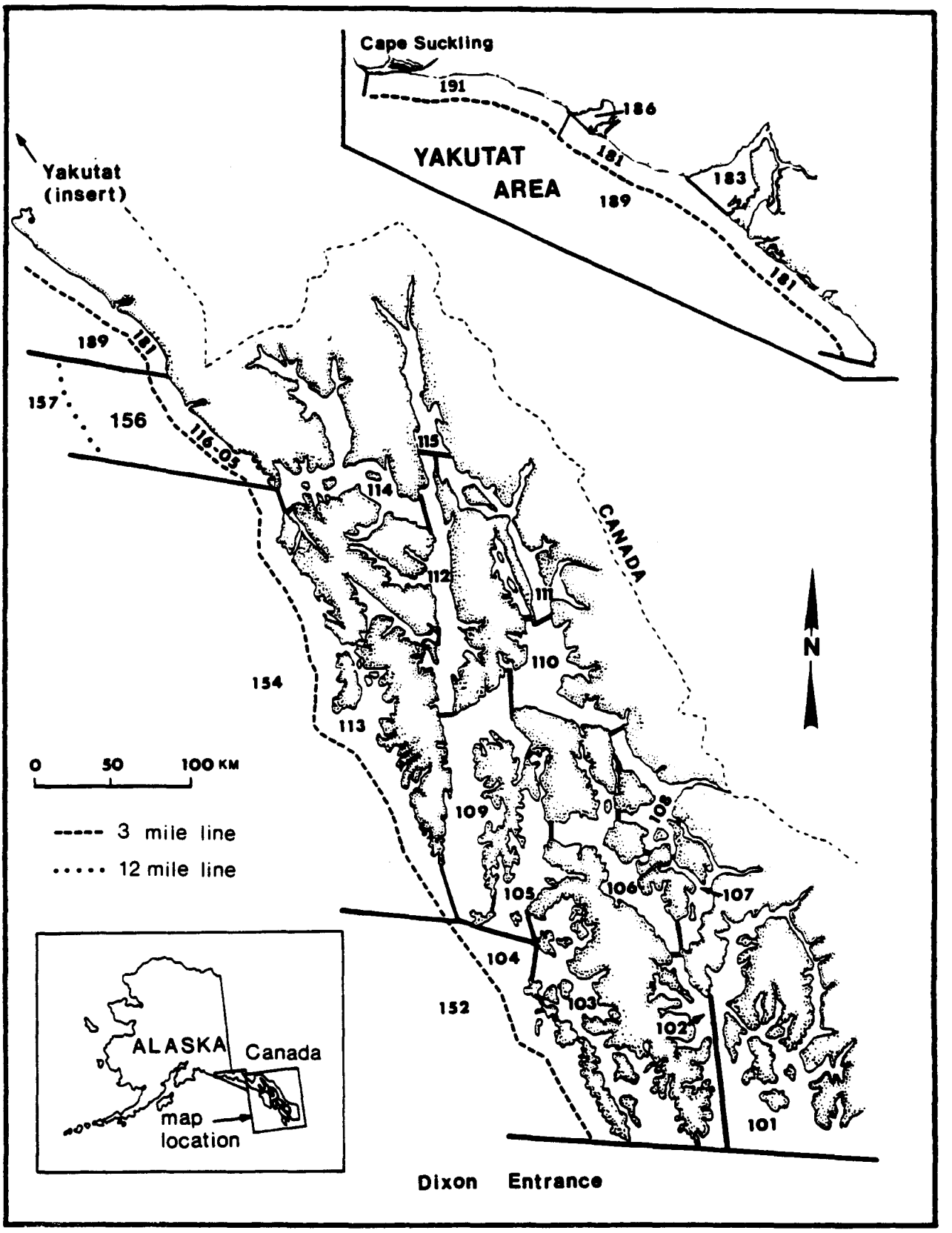


Figure 6. Average weekly proportion of the total coho salmon troll catch (line graph) and estimated troll catch of coded-wire tagged Hugh Smith Lake coho salmon (bar graph) in: (1) the Northwest, Northeast and Southwest Quadrants and (2) the Southeast Quadrant, 1982-1990.

APPENDICES



Appendix A.1. Southeast Alaska statistical fishing districts.

Appendix A.2. Statistical areas of Southeast Alaska belonging to Pacific Marine Fisheries Commission (PMFC) areas and quadrants.

PMFC Area	Abbreviation	Statistical Areas (Districts)
Northern Outside	NOUT	116, 156, 157, 181, 183, 189, 191
Central Outside	COUT	113, 154
Southern Outside	SOUT	103, 104, 152
Southern Inside	SIN	101, 102, 150
Southern Intermediate	SNTR	105, 109, 110
Central Inside	CIN	106, 107, 108
Stephens Passage	STEP	111
Central Intermediate	CNTR	112, 114
Lynn Canal	LYNN	115

Quadrant	Abbreviation	Statistical Areas (Districts)
Northwest	NW	113, 114, 116, 154, 156, 157, 181, 183, 186, 189, 191
Northeast	NE	109, 110, 111, 112, 115
Southwest	SW	103, 104, 150, 152
Southeast	SE	101, 102, 105, 106, 107, 108

Appendix A.3. Statistical weeks used in recording and compiling Southeast Alaska commercial fisheries catch data.

STAT WEEK	YEAR/DATE 1983	YEAR/DATE 1984	YEAR/DATE 1985	YEAR/DATE 1986	YEAR/DATE 1987	YEAR/DATE 1988	YEAR/DATE 1989	YEAR/DATE 1990
1	0101 - 0101	0101 - 0107	0101 - 0105	0101 - 0104	0101 - 0103	0101 - 0102	0101 - 0107	0101 - 0106
2	0102 - 0108	0108 - 0114	0106 - 0112	0105 - 0111	0104 - 0110	0103 - 0109	0108 - 0114	0107 - 0113
3	0109 - 0115	0115 - 0121	0113 - 0119	0112 - 0118	0111 - 0117	0110 - 0116	0115 - 0121	0114 - 0120
4	0116 - 0122	0122 - 0128	0120 - 0126	0119 - 0125	0118 - 0124	0117 - 0123	0122 - 0128	0121 - 0127
5	0123 - 0129	0129 - 0204	0127 - 0202	0126 - 0201	0125 - 0131	0124 - 0130	0129 - 0204	0128 - 0203
6	0130 - 0205	0205 - 0211	0203 - 0209	0202 - 0208	0201 - 0207	0131 - 0206	0205 - 0211	0204 - 0210
7	0206 - 0212	0212 - 0218	0210 - 0216	0209 - 0215	0208 - 0214	0207 - 0213	0212 - 0218	0211 - 0217
8	0213 - 0219	0219 - 0225	0217 - 0223	0216 - 0222	0215 - 0221	0214 - 0220	0219 - 0225	0218 - 0224
9	0220 - 0226	0226 - 0303	0224 - 0302	0223 - 0301	0222 - 0228	0221 - 0227	0226 - 0304	0225 - 0303
10	0227 - 0305	0304 - 0310	0303 - 0309	0302 - 0308	0301 - 0307	0228 - 0305	0305 - 0311	0304 - 0310
11	0306 - 0312	0311 - 0317	0310 - 0316	0309 - 0315	0308 - 0314	0306 - 0312	0312 - 0318	0311 - 0317
12	0313 - 0319	0318 - 0324	0317 - 0323	0316 - 0322	0315 - 0321	0313 - 0319	0319 - 0325	0318 - 0324
13	0320 - 0326	0325 - 0331	0324 - 0330	0323 - 0329	0322 - 0328	0320 - 0326	0326 - 0401	0325 - 0331
14	0327 - 0402	0401 - 0407	0331 - 0406	0330 - 0405	0329 - 0404	0327 - 0402	0402 - 0408	0401 - 0407
15	0403 - 0409	0408 - 0414	0407 - 0413	0406 - 0412	0405 - 0411	0403 - 0409	0409 - 0415	0408 - 0414
16	0410 - 0416	0415 - 0421	0414 - 0420	0413 - 0419	0412 - 0418	0410 - 0416	0416 - 0422	0415 - 0421
17	0417 - 0423	0422 - 0428	0421 - 0427	0420 - 0426	0419 - 0425	0417 - 0423	0423 - 0429	0422 - 0428
18	0424 - 0430	0429 - 0505	0428 - 0504	0427 - 0503	0426 - 0502	0424 - 0430	0430 - 0506	0429 - 0505
19	0501 - 0507	0506 - 0512	0505 - 0511	0504 - 0510	0503 - 0509	0501 - 0507	0507 - 0513	0506 - 0512
20	0508 - 0514	0513 - 0519	0512 - 0518	0511 - 0517	0510 - 0516	0508 - 0514	0514 - 0520	0513 - 0519
21	0515 - 0521	0520 - 0526	0519 - 0525	0518 - 0524	0517 - 0523	0515 - 0521	0521 - 0527	0520 - 0526
22	0522 - 0528	0527 - 0602	0526 - 0601	0525 - 0531	0524 - 0530	0522 - 0528	0528 - 0603	0527 - 0602
23	0529 - 0604	0603 - 0609	0602 - 0608	0601 - 0607	0531 - 0606	0529 - 0604	0604 - 0610	0603 - 0609
24	0605 - 0611	0610 - 0616	0609 - 0615	0608 - 0614	0607 - 0613	0605 - 0611	0611 - 0617	0610 - 0616
25	0612 - 0618	0617 - 0623	0616 - 0622	0615 - 0621	0614 - 0620	0612 - 0618	0618 - 0624	0617 - 0623
26	0619 - 0625	0624 - 0630	0623 - 0629	0622 - 0628	0621 - 0627	0619 - 0625	0625 - 0701	0624 - 0630
27	0626 - 0702	0701 - 0707	0630 - 0706	0629 - 0705	0628 - 0704	0626 - 0702	0702 - 0708	0701 - 0707
28	0703 - 0709	0708 - 0714	0707 - 0713	0706 - 0712	0705 - 0711	0703 - 0709	0709 - 0715	0708 - 0714
29	0710 - 0716	0715 - 0721	0714 - 0720	0713 - 0719	0712 - 0718	0710 - 0716	0716 - 0722	0715 - 0721
30	0717 - 0723	0722 - 0728	0721 - 0727	0720 - 0726	0719 - 0725	0717 - 0723	0723 - 0729	0722 - 0728
31	0724 - 0730	0729 - 0804	0728 - 0803	0727 - 0802	0726 - 0801	0724 - 0730	0730 - 0805	0729 - 0804
32	0731 - 0806	0805 - 0811	0804 - 0810	0803 - 0809	0802 - 0808	0731 - 0806	0806 - 0812	0805 - 0811
33	0807 - 0813	0812 - 0818	0811 - 0817	0810 - 0816	0809 - 0815	0807 - 0813	0813 - 0819	0812 - 0818
34	0814 - 0820	0819 - 0825	0818 - 0824	0817 - 0823	0816 - 0822	0814 - 0820	0820 - 0826	0819 - 0825
35	0821 - 0827	0826 - 0901	0825 - 0831	0824 - 0830	0823 - 0829	0821 - 0827	0827 - 0902	0826 - 0901
36	0828 - 0903	0902 - 0908	0901 - 0907	0831 - 0906	0830 - 0905	0828 - 0903	0903 - 0909	0902 - 0908
37	0904 - 0910	0909 - 0915	0908 - 0914	0907 - 0913	0906 - 0912	0904 - 0910	0910 - 0916	0909 - 0915
38	0911 - 0917	0916 - 0922	0915 - 0921	0914 - 0920	0913 - 0919	0911 - 0917	0917 - 0923	0916 - 0922
39	0918 - 0924	0923 - 0929	0922 - 0928	0921 - 0927	0920 - 0926	0918 - 0924	0924 - 0930	0923 - 0929
40	0925 - 1001	0930 - 1006	0929 - 1005	0928 - 1004	0927 - 1003	0925 - 1001	1001 - 1007	0930 - 1006
41	1002 - 1008	1007 - 1013	1006 - 1012	1005 - 1011	1004 - 1010	1002 - 1008	1008 - 1014	1007 - 1013
42	1009 - 1015	1014 - 1020	1013 - 1019	1012 - 1018	1011 - 1017	1009 - 1015	1015 - 1021	1014 - 1020
43	1016 - 1022	1021 - 1027	1020 - 1026	1019 - 1025	1018 - 1024	1016 - 1022	1022 - 1028	1021 - 1027
44	1023 - 1029	1028 - 1103	1027 - 1102	1026 - 1101	1025 - 1031	1023 - 1029	1029 - 1104	1028 - 1103

Appendix B.1. Estimated weekly proportion of the total troll catch of coded-wire tagged Berners River coho salmon, 1982, 1983 and 1985-1990.

Stat. Week	Year 1982	1983	1985	1986	1987	1988	1989	1990	Average
25	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
26	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
27	0.0000	0.0000	0.0000	0.0647	0.0000	0.0000	0.0000	0.0000	0.0081
28	0.0000	0.0193	0.0370	0.0199	0.0000	0.0000	0.0000	0.0269	0.0129
29	0.0000	0.0000	0.0000	0.1329	0.0000	0.0000	0.0000	0.0354	0.0210
30	0.0244	0.0761	0.1039	0.0791	0.1037	0.0167	0.0313	0.0173	0.0566
31	0.0486	0.0566	0.0664	0.0245	0.1108	0.0000	0.0509	0.0547	0.0516
32	0.0000	0.0832	0.0377	0.0592	0.0513	0.0000	0.0538	0.0723	0.0447
33	0.0952	0.0000	0.0000	0.0181	0.0000	0.0869	0.0484	0.0434	0.0365
34	0.3578	0.2010	0.0000	0.1107	0.2010	0.0684	0.0619	0.1346	0.1419
35	0.0985	0.1663	0.1227	0.1585	0.0323	0.1664	0.3296	0.2301	0.1631
36	0.0000	0.1655	0.3482	0.2243	0.2880	0.3805	0.1329	0.1555	0.2119
37	0.1449	0.1165	0.2380	0.1081	0.1839	0.2449	0.2342	0.1923	0.1828
38	0.0000	0.1155	0.0461	0.0000	0.0290	0.0329	0.0570	0.0375	0.0398
39	0.2306	0.0000	0.0000	0.0000	0.0000	0.0033	0.0000	0.0000	0.0292
Total	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Sample	25	77	50	87	43	63	49	303	

Appendix B.2. Estimated weekly proportion of the total troll catch of coded-wire tagged Ford Arm Lake coho salmon, 1982, 1983 and 1985-1990.

Stat. Week	Year 1982	1983	1985	1986	1987	1988	1989	1990	Average
25	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
26	0.0000	0.0000	0.0000	0.0106	0.0484	0.0000	0.0000	0.0000	0.0074
27	0.0000	0.0000	0.4280	0.1164	0.0613	0.0092	0.0071	0.0000	0.0777
28	0.0000	0.1662	0.0429	0.1967	0.0682	0.0278	0.0000	0.0923	0.0743
29	0.1584	0.1326	0.0205	0.1584	0.0843	0.0608	0.0520	0.1765	0.1054
30	0.0844	0.1376	0.0752	0.1347	0.1918	0.1081	0.1084	0.0737	0.1142
31	0.1006	0.1775	0.0385	0.0828	0.1094	0.0278	0.1209	0.1994	0.1071
32	0.0000	0.1025	0.0546	0.1558	0.1500	0.0000	0.1899	0.2116	0.1080
33	0.2394	0.0157	0.1003	0.0611	0.0509	0.1464	0.1044	0.1332	0.1064
34	0.1235	0.0895	0.0000	0.0000	0.1208	0.1496	0.0669	0.0000	0.0688
35	0.1020	0.0991	0.1660	0.0297	0.0955	0.0000	0.2455	0.0981	0.1045
36	0.1917	0.0567	0.0673	0.0538	0.0194	0.4212	0.0746	0.0000	0.1106
37	0.0000	0.0000	0.0000	0.0000	0.0000	0.0450	0.0156	0.0152	0.0095
38	0.0000	0.0226	0.0067	0.0000	0.0000	0.0041	0.0148	0.0000	0.0060
39	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Total	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Sample	37	83	49	85	65	148	206	156	

Appendix B.3. Estimated weekly proportion of the total troll catch of coded-wire tagged Hugh Smith Lake coho salmon, 1982-1990.

Stat. Week	Year 1982	1983	1984	1985	1986	1987	1988	1989	1990	Average
25	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
26	0.0000	0.0000	0.0402	0.0000	0.0000	0.0276	0.0000	0.0000	0.0000	0.0075
27	0.0085	0.0000	0.0000	0.0000	0.0073	0.0183	0.0000	0.0229	0.0310	0.0098
28	0.0000	0.0415	0.0000	0.0492	0.0723	0.0000	0.0000	0.0000	0.0608	0.0249
29	0.1134	0.0867	0.0655	0.1351	0.1081	0.1910	0.0000	0.0379	0.1511	0.0988
30	0.0628	0.1481	0.0000	0.1689	0.1246	0.0430	0.0573	0.2477	0.0871	0.1044
31	0.0950	0.1010	0.2028	0.1394	0.1216	0.1554	0.0474	0.0788	0.1531	0.1216
32	0.0000	0.1224	0.1365	0.0713	0.1217	0.0924	0.0000	0.0631	0.1175	0.0805
33	0.2632	0.0154	0.1014	0.1189	0.0553	0.0000	0.2941	0.1359	0.1052	0.1210
34	0.1111	0.2405	0.0000	0.0000	0.1007	0.2527	0.1498	0.0632	0.0677	0.1095
35	0.2396	0.0745	0.0764	0.1498	0.1378	0.1152	0.1156	0.1872	0.1216	0.1353
36	0.0481	0.0626	0.1317	0.0747	0.0794	0.0863	0.3358	0.0205	0.0279	0.0963
37	0.0170	0.0686	0.1871	0.0521	0.0284	0.0181	0.0000	0.1428	0.0631	0.0641
38	0.0055	0.0348	0.0584	0.0406	0.0428	0.0000	0.0000	0.0000	0.0139	0.0218
39	0.0358	0.0039	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0044
Total	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Sample	64	107	67	114	155	52	22	61	120	

Appendix B.4. Estimated weekly proportion of the total troll catch of coded-wire tagged Hugh Smith Lake coho salmon in the Northwest, Northeast and Southwest Quadrants, 1982-1990.

Stat. Week	Year 1982	1983	1984	1985	1986	1987	1988	1989	1990	Average
25	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
26	0.0000	0.0000	0.0534	0.0000	0.0000	0.0310	0.0000	0.0000	0.0000	0.0094
27	0.0000	0.0000	0.0000	0.0000	0.0084	0.0205	0.0000	0.0128	0.0395	0.0090
28	0.0000	0.0556	0.0000	0.0601	0.0827	0.0000	0.0000	0.0000	0.0694	0.0298
29	0.1453	0.1084	0.0871	0.1515	0.1236	0.2139	0.0000	0.0511	0.1801	0.1179
30	0.0735	0.1800	0.0000	0.2001	0.1424	0.0320	0.0705	0.2856	0.0956	0.1200
31	0.0861	0.1144	0.2695	0.1310	0.1276	0.1394	0.0583	0.0763	0.1902	0.1325
32	0.0000	0.1322	0.1814	0.0516	0.1285	0.0898	0.0000	0.0498	0.1494	0.0870
33	0.2845	0.0207	0.1348	0.1147	0.0528	0.0000	0.3070	0.1215	0.1217	0.1286
34	0.1229	0.2301	0.0000	0.0000	0.1151	0.2477	0.1449	0.0852	0.0372	0.1092
35	0.2728	0.0562	0.0000	0.1470	0.1239	0.1291	0.1423	0.2344	0.0839	0.1322
36	0.0149	0.0593	0.1263	0.0748	0.0673	0.0966	0.2770	0.0151	0.0000	0.0813
37	0.0000	0.0231	0.1062	0.0359	0.0147	0.0000	0.0000	0.0681	0.0260	0.0305
38	0.0000	0.0200	0.0413	0.0333	0.0130	0.0000	0.0000	0.0000	0.0071	0.0127
39	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Total	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Sample	44	73	44	87	128	45	18	44	96	

Appendix B.5. Estimated weekly proportion of the total troll catch of coded-wire tagged Hugh Smith Lake coho salmon in the Southeast Quadrant, 1982-1990.

Stat. Week	Year 1982	1983	1984	1985	1986	1987	1988	1989	1990	Average
25	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
26	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
27	0.0386	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0517	0.0000	0.0100
28	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0293	0.0033
29	0.0000	0.0227	0.0000	0.0614	0.0000	0.0000	0.0000	0.0000	0.0449	0.0143
30	0.0250	0.0542	0.0000	0.0292	0.0000	0.1350	0.0000	0.1391	0.0561	0.0487
31	0.1266	0.0613	0.0000	0.1771	0.0797	0.2883	0.0000	0.0859	0.0169	0.0929
32	0.0000	0.0934	0.0000	0.1595	0.0735	0.1139	0.0000	0.1013	0.0000	0.0602
33	0.1874	0.0000	0.0000	0.1377	0.0730	0.2940	0.2384	0.1770	0.0448	0.1280
34	0.0692	0.2711	0.0000	0.0000	0.0000	0.0000	0.1709	0.0000	0.1797	0.0768
35	0.1213	0.1284	0.3086	0.1622	0.2347	0.0000	0.0000	0.0519	0.2600	0.1408
36	0.1659	0.0723	0.1483	0.0745	0.1638	0.1688	0.5907	0.0359	0.1303	0.1723
37	0.0774	0.2026	0.4327	0.1247	0.1243	0.0000	0.0000	0.3572	0.1992	0.1687
38	0.0253	0.0784	0.1104	0.0737	0.2510	0.0000	0.0000	0.0000	0.0387	0.0642
39	0.1633	0.0156	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0199
Total	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Sample	20	34	23	27	27	7	4	17	24	